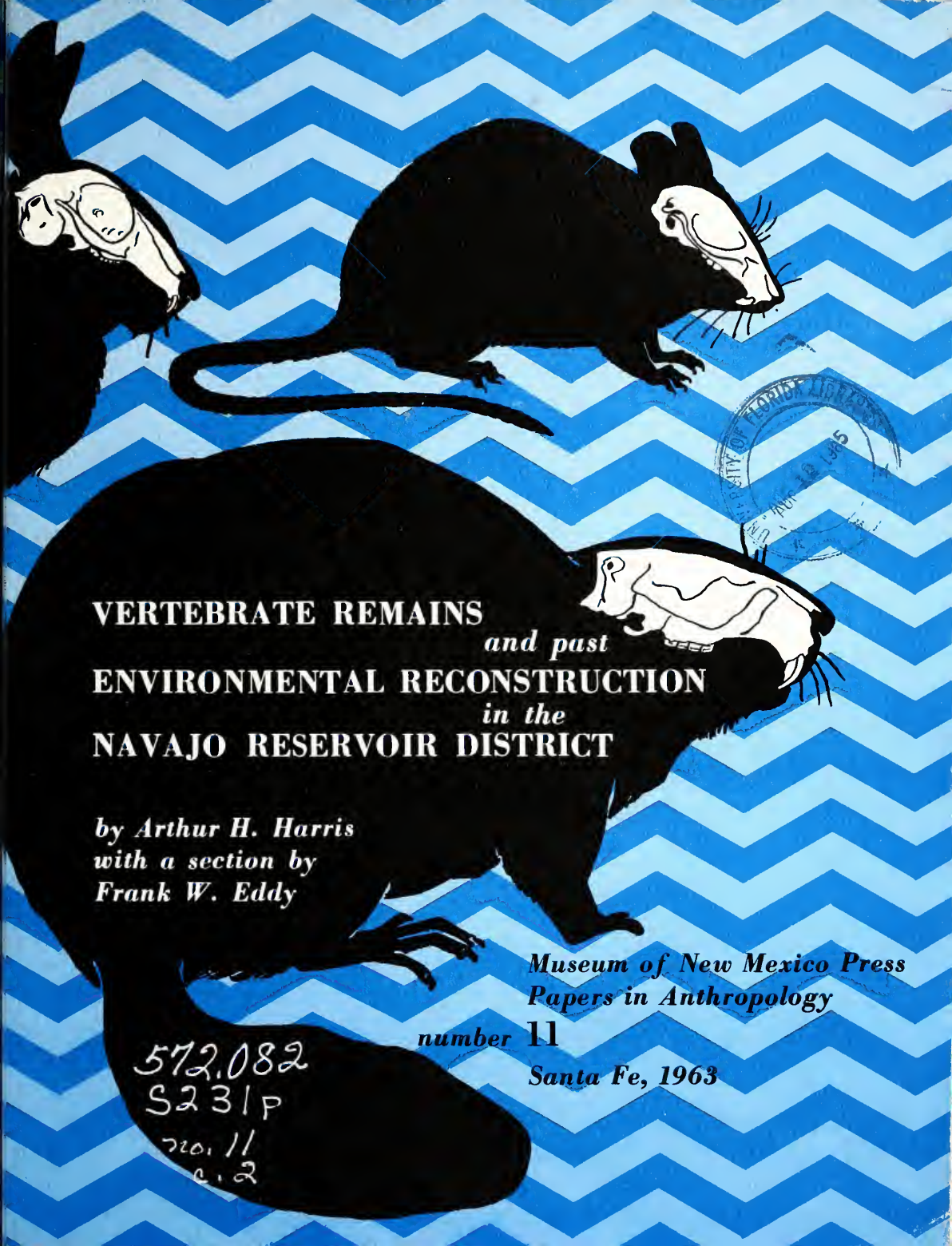


VERTEBRATE REMAINS *and past* ENVIRONMENTAL RECONSTRUCTION *in the* NAVAJO RESERVOIR DISTRICT

by Arthur H. Harris
with a section by
Frank W. Eddy

Museum of New Mexico Press
Papers in Anthropology
number 11
Santa Fe, 1963

572.082
S231p
no. 11
c. 2

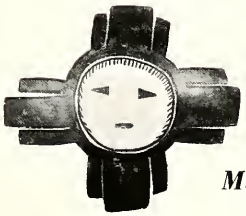
UNIVERSITY
OF FLORIDA
LIBRARIES

VERTEBRATE REMAINS *and past* ENVIRONMENTAL RECONSTRUCTION *in the* NAVAJO RESERVOIR DISTRICT

by Arthur H. Harris
with a section by
Frank W. Eddy

number 11

Museum of New Mexico
Papers in Anthropology
Santa Fe, 1963



Museum of New Mexico Press

572.982
S231p
no. 11
c. 2

A Salvage Archaeology program conducted by the Museum of New Mexico in co-operation with the National Park Service, Southwest Region, Department of the Interior, in the Navajo Reservoir District of the Upper Colorado Storage Project.

Edited by

Eastburn R. Smith

© Museum of New Mexico Press 1963

NAVAJO PROJECT STUDIES X

Library of Congress Catalog
Card Number: 63-64424

Price $2.00

TABLE OF CONTENTS

PREFACE AND ACKNOWLEDGEMENTS 7

INTRODUCTION 8

The Present Environment 9
Bone Identification and Interpretation 10

MATERIALS AND METHODS 14

SPECIES AND GENERIC ACCOUNTS 28

Anura 28
Scaphiopus sp. Spadefoot Toads 28
Bufo sp. Common Toads 28
Bufo woodhousei. Woodhouse's Toad 28
Rana pipiens. Leopard Frog 28
Chelonia. Turtles 28
Sceloporus sp. Spiny Lizards 29
Sceloporus undulatus. Eastern Fence Lizard 29
Ochotona princeps. Pika 29
Sylvilagus auduboni and S. nuttali. Desert and Nuttall's Cottontails 29
Lepus sp. Jack Rabbits. 32
Cf. Lepus americanus. Snowshoe Rabbit 34
Eutamias cf. quadrivittatus. Colorado Chipmunk 34
Marmota flaviventris. Yellow-bellied Marmot 34
Citellus leucrus. White-tailed Antelope Squirrel 35
Citellus variegatus. Rock Squirrel 35
Cynomys gunnisoni. Gunnison's Prairie Dog. 36
Sciurus aberti. Tassel-eared Squirrel 36
Tamiasciurus hudsonicus. Red Squirrel 36
Thomomys sp. Pocket Gophers 36
Perognathus sp. Pocket Mice 38
Dipodomys ordi. Ord's Kangaroo Rat 39
Castor canadensis. Beaver 41
Reithrodontomys sp. Harvest Mice. 41
Peromyscus sp. White-foot Mice 41
Onychomys leucogaster. Northern Grasshopper Mouse 41
Neotoma sp. Wood Rats 42
Microtus sp. Voles 42
Microtus pennsylvanicus. Meadow Vole 43
Microtus longicaudus. Long-tailed Vole 43
Ondatra zibethicus. Muskrat 44
Erethizon dorsatum. Porcupine 44
Canis sp. Dogs 44
Vulpes sp. Foxes. 44
Urocyon cinereoargenteus. Gray Fox 44
Ursus cf. americanus. Black Bear 45
Bassariscus astutus. Ringtail 45
Martes americanus. Marten 45
Mustela frenata. Long-tailed Weasel 45
Taxidea taxus. Badger 45
Felis concolor. Mountain Lion 45
Lynx cf. rufus. Bobcat. 45
Equus cf. caballus. Horse. 45
Tayassu sp. Peccary 45
Cervus canadensis. Wapiti 45
Odocoileus hemionus. Mule Deer 45
Antilocapra americana. Pronghorn 46
Ovis canadensis. Mountain Sheep. 46

DISCUSSION AND CONCLUSIONS 47

APPENDIX A - CULTURAL CONSIDERATIONS IN THE STUDY OF PREHISTORIC ANIMALS 60

Reservoir Cultural Sequence 60
Archaic Period 60
Pueblo Period 61
Navajo Period 64
Historic Period 65

Dating Cultural and Biological Events 65
Associations 65
Ceramic Dating 66
Dendrochronology. 67
Other Guides to Dating 67
Conclusions 68

APPENDIX B - List of Previous Navajo Project Studies 69

BIBLIOGRAPHY 70

TABLE

I Minimum Number of Individuals by Geographic Section and Cultural Phase 15

LIST OF FIGURES

1. Map of the Navajo Reservoir District showing sites from which bones have been identified and the geographic sections in which the sites are located 11

2. Identification of faunal remains by geographic section and archaeological site. 17

3. Frequencies of Sylvilagus auduboni in each sample plotted by geographic section and cultural phases. 30

4. Frequencies of Sylvilagus nuttalli plotted as in Figure 3 31

5. Graph showing ratios of Sylvilagus nuttali to S. auduboni. 32

6. Frequencies of Lepus sp. plotted as in Figure 3 33

7. Frequencies of Marmota flaviventris plotted as in Figure 3. 35

8. Frequencies of Thomomys sp. plotted as in Figure 3 37

9. Frequencies of Perognathus sp. plotted as in Figure 3 38

10. Frequencies of Dipodomys ordi plotted as in Figure 3 39

11. Dipodomys ordi habitat on continental divide, ca. 10 mi. west and $9\frac{1}{2}$ mi. south of Hospah, McKinley Co. 40

12. Onychomys leucogaster habitat, Cañada Larga, $1\frac{1}{2}$ mi. north and 5 mi. west of Lindrith, Rio Arriba Co. 41

13. Frequencies of Onychomys leucogaster plotted as in Figure 3 42

14. Frequencies of Microtus longicaudus plotted as in Figure 3. 43

15. List of identified animals not found useful in this study 47

16. Lists of animals identified from the Navajo Reservoir District which do not occur there at present . 48

17. List of animals which are useful as environmental indicators and now occur in some portion of the Navajo Reservoir District 48

18. Graph showing distribution in per cent of several sensitive indicators by cultural phase 49

19. Minimal southern limits of distribution of M. longicaudus and S. nuttalli and northern limit of distribution of S. auduboni during Los Pinos Phase. 51

20. Minimal southern limits of distribution of M. longicaudus and S. nuttalli and northern limit of distribution of S. auduboni during Sambrito Phase 52

21. Minimal southern limits of distribution of M. longicaudus and S. nuttalli and northern limit of distribution of S. auduboni during Rosa Phase 53

22. Minimal southern limits of distribution of M. longicaudus and S. nuttalli and northern limit of distribution of S. auduboni during Piedra Phase 54

23. Minimal southern limits of distribution of M. longicaudus and S. nuttalli and northern limit of distribution of S. auduboni during Arboles Phase 55

24. Approximate southern limits of distribution of M. longicaudus and S. nuttalli and northern limit of distribution of S. auduboni at present 56

Digitized by the Internet Archive
in 2011 with funding from
LYRASIS Members and Sloan Foundation

http://www.archive.org/details/vertebrateremain00harr

PREFACE AND ACKNOWLEDGEMENTS

The following report is the 10th in a series covering cultural and environmental studies which are being conducted in the area now being flooded by Lake Navajo in northwestern New Mexico and southwestern Colorado. The laboratory analysis and writing for this present paper were conducted as a sub-contract to the Biology Department, University of New Mexico, during the fiscal year 1962-63, and were financed as part of a contract granted to the Museum of New Mexico from the National Park Service, Southwest Region, for salvage archaeology. The report is based on animal bone remains recovered from thirty-seven archaeological sites which lie within the Navajo Reservoir District. These sites were excavated from 1956-1962 as part of the cultural studies program by the Navajo Project staff, Museum of New Mexico. The studies have resulted in a cultural history of the District, which is briefly described in Appendix A as a record of the context from which the bones have been derived, and they provide some understanding of the methods of dating and designating cultures and their component parts, the phases. The total list of Project Studies is carried as Appendix B, and should be consulted for the broader picture of the Reservoir researches.

The author, a field biologist with the Museum of Southwestern Biology, Department of Biology, University of New Mexico, wishes to express his appreciation to the Division of Research, Museum of New Mexico, and particularly to A.E. Dittert and F.W. Eddy of that institution, for the financial and personal support that furnished the opportunity for this study. Eddy also has been responsible for organization and transmittal of the necessary archaeological data and deserves thanks for successfully carrying out the difficult job of liason between two different disciplines.

I also wish to express my gratitude to the Museum of Southwestern Biology which has supplied facilities for research and access to its collections. Particular thanks are due J.S. Findley, Curator of Mammals and Birds, who has offered many aids and suggestions during the research and report writing, and to C.J. Jones, Assistant Curator, who has not only supplied much aid, but who also has cheerfully tolerated the clutter necessary during the various phases of the study.

INTRODUCTION

In recent years, the archaeologist has utilized many new techniques to obtain the greatest possible amount of information from his excavations. Dendrochronology, geochemistry, and palynology are a few of such aids to interpretation. Other less esoteric fields seldom have been utilized to the fullest extent. One such source of information, little used in other than Early Man studies, is that of vertebrate remains.

The student of Early Man often bases his description of the past environment at a given site upon the recovered faunal remains (often with considerable naivete); the archaeologist who deals with more recent times often entirely ignores the associated fauna. The reasons for this are many, but familiar: lack of time, money, personnel, and interest. Ordinarily, if anything is done with such non-artifactual materials, it is through badgering a zoologist, qualified or not, into identifying the bone remains and supplying a list of animals recovered from the site. The list may then appear in the site report, often as an appendix. Such lists usually are useless to the archaeologist, who has no idea of what to do with them; and are not seen by most zoologists, who do not customarily read archaeological reports. In short, seldom do such "studies" result in useful interpretations of the environment in which prehistoric man lived, or in useful biological information.

In the late 1950's, it appeared that many of the stumbling blocks to a reasonably thorough study could be removed in one particular instance. Authorization of salvage archaeology in the area to be altered by the construction of Navajo Dam indicated that funds would be available for a large archaeological program. The assignment of Dittert to head this program supplied an interested archaeologist. The period allowed before completion of construction gave sufficient time to carry out a program. Finally, personnel for excavation and for faunal studies was available. The actual faunal studies program was started in late summer of 1958; this report terminates the Navajo Reservoir portion of these studies.

The studies have been carried out in two separate, but essential phases. Two weeks in 1958 and the summers of 1959 and 1960 were spent in investigations of the modern geographic and ecological distributions of vertebrates in the dam and Reservoir areas and in surrounding habitats. The report of this phase of the investigations (Harris, 1963) is primarily biological in content, but is a necessary preliminary to interpretation of prehistoric remains.

The identification portion of the second phase was begun by R.B. Forbes under a research assistantship, supported by the Navajo Reservoir Project, at the Department of Biology, University of New Mexico. The remainder of the identification, the rechecking of earlier identifications, and the interpretation have been done by myself.

THE PRESENT ENVIRONMENT

The Navajo Dam and Reservoir area has been described in some detail in other reports (Dittert, Hester, and Eddy, 1961; Pendergast, 1961; Harris, 1963), but some of the salient features may bear repeating here. The dam has been constructed on the San Juan River in northwestern New Mexico, about fourteen airline miles south of the Colorado state line. The Reservoir, at its maximum extent, will be about thirty-four miles long. It will extend some five to six miles into Colorado on the Piedra and San Juan Rivers, and reach to about three-quarters of a mile south of the Colorado line along the Pine River.

In the north, low mountains (to about 8500 ft.) support a mixed forest and woodland growth consisting mainly of ponderosa pine (Pinus ponderosa), Douglas fir (Pseudotsuga taxifolia), Rocky Mountain juniper (Juniperus scopulorum), Colorado pinyon (Pinus edulis), Gambel oak (Quercus gambelii), and occasional aspens (Populus tremuloides). Big sagebrush (Artemisia tridentata) often occurs as an understory plant or in open places. In the river valleys, cottonwoods (Populus wislizeni and P. angustifolia) are common, as are several willows (Salix spp.).

Somewhat farther south, though still mostly north of the State line, low hills support woodland growth of Colorado pinyon and Gambel oak, along with considerable one-seeded juniper (J. monosperma) and such shrubs as mountain mahogany (Cercocarpus spp.) and squawberry (Rhus trilobata). Big sagebrush occurs in open areas and as an understory plant. The more level areas often consist of irrigated croplands. Sedges (Scirpus spp.), cattails (Typha latifolia), willows, and grasses occur along irrigation ditches while big sagebrush, snakeweed (Gutierrezia spp.), and greasewood (Sarcobatus vermiculatus) occur on the unirrigated flats.

Near the State line, the San Juan and Pine Rivers enter deep canyons, cut through strata of shales and sandstones of Paleocene age. This topographic feature, the Junction Land Form of Dittert, et al. (1961), continues south to and beyond the dam. Vegetation on top of the plateau, through which the canyons are cut, varies from well developed pinyon-juniper woodland to oak scrub to open flats of big sagebrush. Grasses are present, but scant, particularly in areas of sagebrush. Mountain mahogany, squawberry, and other shrubs are often mixed with the trees and form the major plant growth on some slopes. The situation on canyon walls is similar to that on the plateau top, but shrubs form a somewhat larger percentage of the plant growth. In some canyons and sometimes on the plateau top, small stands of Douglas fir and, less commonly, ponderosa pine occur. The almost level terraces of the major canyons are covered mainly with big sagebrush. The river bottomlands support dense growths of Rio Grande cottonwood, willows, wild olive (Forestiera neomexicana), and box elder (Acer negundo) in some areas; other areas lack trees, being covered with low willows, big sagebrush, snakeweed, and greasewood, or even may lack almost completely any permanent vegetation. Small areas of sedges may appear but are uncommon.

South of Navajo Dam, approximately south and west of Blanco, New Mexico, strong topographic relief becomes rarer, appearing only along drainage ways and as occasional, isolated remnants of the plateau-forming strata. Pinyons and junipers occur in the higher areas, usually sparsely, surrounding rocky outcrops and on steeper slopes. The remainder of the area consists of sagebrush or grasslands.

The Navajo Project archaeologists have divided the study area into a number of arbitrary geographic sections for ease of interpretation and presentation of data (Dittert, et al., 1961; Fig. 3). These sections are shown in Figure 1.

BONE IDENTIFICATION AND INTERPRETATION

Although some archaeologists and zoologists are familiar with the theoretic principles and the basic limitations of interpreting past environments by bone remains, most are not. Therefore, a review here seems not out of place.

At its simplest, the interpretation of bone remains rests on the following premises:

(1) All animals have a limited set of environmental conditions under which they may exist, and these conditions are not the same for all kinds of animals.

Factors which make up suitable conditions include certain ranges of climatic factors (temperature, precipitation, humidity, etc.) and presence of suitable kinds and amounts of food, cover, and home sites. Presence, absence, or population levels of competitors, predators, parasites, and pathogenic organisms also are factors affecting suitability of the environment.

Of the factors mentioned above, many of the nonclimatic factors are greatly influenced by climate. Food, cover, and often the presence or absence of home sites, particularly, depend in large part on the flora of an area, which, in turn, is greatly influenced by climate. There usually is present an effect occasioned not only by such obvious features as annual precipitation and mean temperature, but by more nebulous relationships, such as annual distribution of precipitation, coldest temperatures during a several-year period, and severity of periodic droughts.

The tolerances of various kinds of vertebrates often differ only subtly, allowing in theory, elucidation of even minor environmental changes. As discussed below, our lack of detailed knowledge of factors restricting the distribution of vertebrates is a serious obstacle to attaining such fine interpretation.

(2) Natural occurrence of an animal in a given area implies the existence at the time of occurrence of the set of environmental conditions under which it may exist. Natural occurrence of different kinds of animals with different tolerances allows estimation of the environmental parameters.

Since few if any kinds of animals have exactly the same tolerances for all factors of the environment, the composition of the fauna reveals parameters of the environment. As a simple example, the presence of an animal which cannot survive freezing temperatures, together with an animal which cannot survive temperatures exceeding 100°F., tells us that the environment is such that the temperature range lies somewhere between these two extremes.

(3) Absence in a given area implies either a set of conditions unsuitable to the animal, lack of access to the area owing to conditions outside the area, or lack of sufficient time to reach the area from elsewhere.

Absence of an animal in a given area does not necessarily mean that conditions are unsuitable. Presumably, a number of forested mountain areas in the Southwest and Mexico are suitable for forest-dwelling animals that do not occur there. This implies that such animals are barred from these suitable areas by the unsuitable conditions in the surrounding lowlands. That suitable conditions may occur within and between

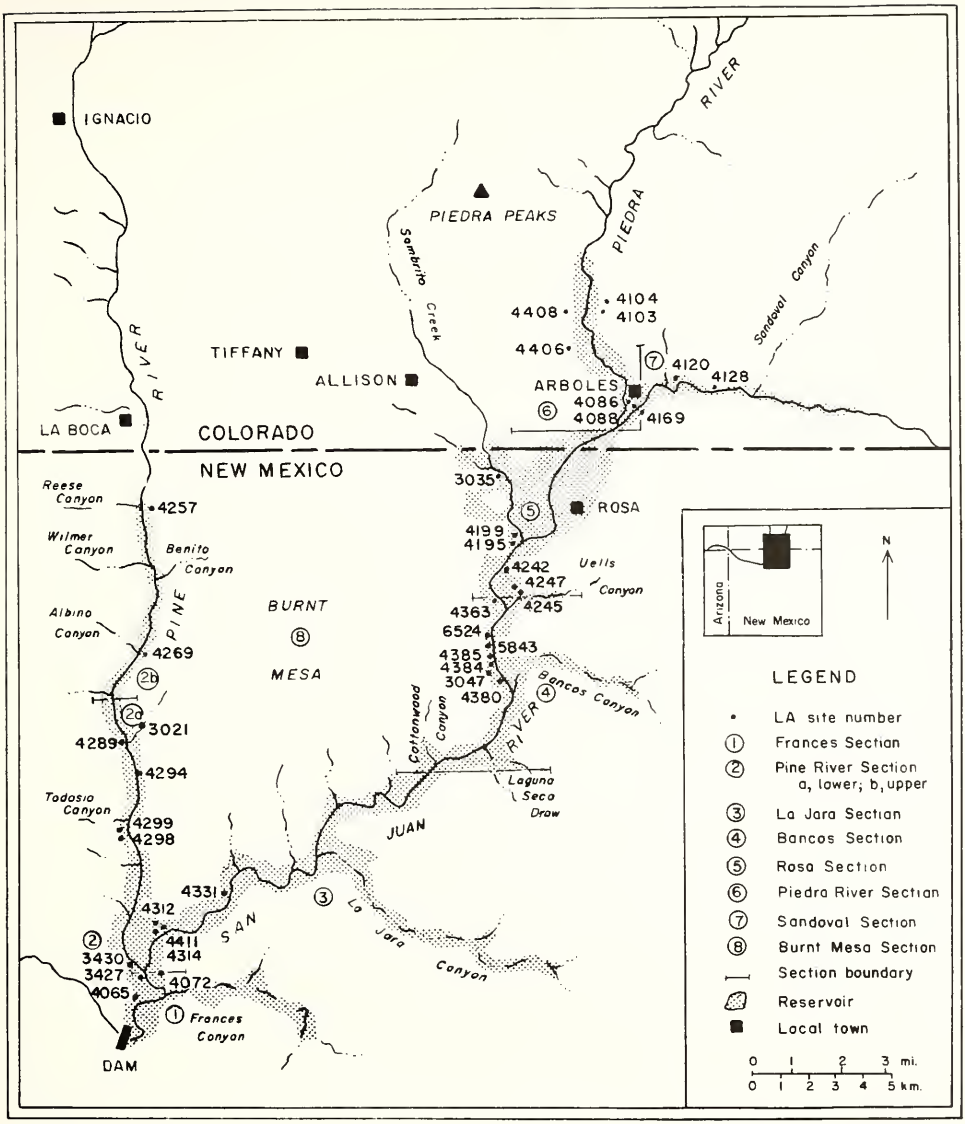


Fig. 1. Map of the Navajo Reservoir District showing sites from which bones have been identified and the geographic sections in which the sites are located.

an uninhabited and an inhabited area may be seen clearly from the examples of several birds introduced into the United States. After introduction on the East Coast (of the English Sparrow, for example), a number of years passed before the birds appeared in many of the suitable areas elsewhere on the continent.

(4) Changes in environmental conditions result in changes in faunal composition.

When environmental changes result in conditions exceeding the tolerances of some members of the fauna, these members disappear. The same changes may allow other members to enter the area.

(5) Sufficient elements of a fauna may be recovered and dated as to allow a statement of conditions extant at a given time and place.

This premise is the weakest of the set and will be discussed further.

In arriving at a correct interpretation, sources of error arise in deposition, collection, dating, identification, and correlation of faunal elements with environmental conditions.

Original deposition of faunal remains is outside the control of the archaeologist and zoologist, but it must be recognized that the deposits seldom are representative of the entire vertebrate fauna of the area.

The location of the site itself biases the recoverable fauna, in that, normally, all biological niches are not equally present at the site. Thus, a river valley site will contain an overrepresentation of those kinds of vertebrates that live in river valley habitats and an underrepresentation of other forms.

Animals of certain habit are more apt to be preserved in a site than those of other habits. For example, nook and cranny dwellers are apt to be overrepresented in caves and rock shelters, compared to, say, arboreal forms. Absence of a given animal in the excavated material cannot be taken as absolute proof of its absence from the fauna at the time of deposition.

Man, himself, has biased the sample. Game animals, ceremony-related animals, and curiosities are brought to the site, often from great distances. Beyond these factors, the very presence of man may change the composition of the fauna within the area. His dwellings provide home sites for some animals, his garbage and crops attract other kinds.

After original deposition, further bias may be introduced by disturbances by burrowing animals geological processes, and differential preservation of deposited material.

The recovery and dating of vertebrate skeletal elements lie, primarily, in the province of the archaeologist. Ideally, the interpreter should have at his disposal all bones and bone fragments occurring within a site. Lack of time often rules out this situation, particularly in salvage archaeology. Available funds and skill of the excavator, also, are important factors. An excavator who sees only large bones collects a considerably different sample from one who is concerned with the smallest fragment.

At best, the recovered and identified material is only a sample of the fauna of the area at the time of deposition, and is subject to the general limitations and sources of error common to all samples.

Dating is discussed in some detail by Eddy in Appendix A. For the most part, the zoologist is at the mercy of the archaeologist, but such features as horse bones in pre-Spanish, Pueblo Period deposits may warn the zoologist that mixing of deposits has occurred, or that the archaeologist has erred.

A crucial part in the role of the zoologist is the identification of the bones placed at his disposal. Lapses in identification are undoubtedly common. Reasons for mis-

identifications are many, but the most common source of error is the lack of suitable comparative collections. Vertebrates show considerable amounts of individual variation, owing to genetic makeup, age, sex, and environmental conditions to which the individual has been subjected. Unless the identifier has access to comparative material sufficient to show a goodly portion of the range of individual variation, important material may be discarded as unidentifiable or may be misidentified.

Another source of misidentification appears when a comparative collection does not contain individuals of all the reasonably expected species. A specimen may be found to closely approach the characteristics of a certain species represented in the collections and, since its characteristics are nearer to this species than to any other in the comparative collection, may be identified as belonging to that species. In actuality, the specimen may be from a member of a different, morphologically similar species.

Few detailed comparative osteological studies have been made with the aim of providing means of separating species on the basis of isolated bony elements. This is owing, primarily, to lack of material and lack of interest. Unless a large series of skeletons of a single species is available, little can be said about the characteristics of the species' skeletal elements, and the parameters for characteristics of the various elements cannot be estimated by statistical treatment. The coincidence of sufficiently complete comparative collections and of zoologists with the interest, time, training, and support to undertake comparative osteological studies is low.

General correlation of a fauna, as sampled from archaeological work, with the environment with which the fauna was associated is relatively easy when conditions were widely different from the present or some other time level. It is difficult to confuse a tropical rainforest fauna with a semi-arid steppe fauna, or even a grassland fauna with a forest fauna when the faunas are well-known. Most post-Pleistocene changes, however, were of considerably lesser magnitude. The major obstacles to revealing relatively subtle environmental changes lie in our lack of detailed knowledge of the tolerances of the various vertebrate species and in our lack of detailed knowledge of present-day distribution. With care, and preferably, with field-trapping and observation in the area of the sites, these deficiencies can be minimized.

It should be noted that not all vertebrates are equally useful for correlation. Many possess tolerances so wide as to be useless for interpretation of changes of the magnitude expectable in the time and area dealt with here. Unfortunately, many of the larger and commoner animals fall into this category. Those with narrower tolerances are the sensitive indicators upon which most interpretation must rely. Since most of these forms are small, they are the most likely to be overlooked or destroyed in excavation.

MATERIALS AND METHODS

The bone materials and associated data used in this study were obtained from the Navajo Project. Bird bones were separated from bones of other vertebrates and sent to the Southwest Archaeological Center for identification and interpretation by L. L. Hargrave.

Although a small amount of earlier identification was done by Forbes, I have checked all identifications and am solely responsible for the identifications appearing in this report.

The total number of bone fragments is unrecorded, but is estimated to be between 12,000 and 15,000. More than 4,100 non-bird bones or bone fragments were considered identifiable to some useful level and were catalogued into the "Archaeological and Fossil Bone Catalogue" of the Museum of Southwestern Biology. Specimens were saved, as a record of kinds and numbers present at the various sites and stratigraphic levels, as a source of more precise identifications (to a lower taxonomic category) as further research allows, and for possible future biological studies. A small number of unidentified elements has been saved, but not catalogued, in the hope that they may be identified at some later date; material considered as unidentifiable has been discarded.

Identification was accomplished by direct comparison to skeletal material in the extensive collections of the Museum of Southwestern Biology whenever possible. In addition, published keys and descriptions were utilized.

Several degrees of certainty were indicated on the original worksheets. A "cf." before a word indicated that identification to that level was very likely, but not positive. Thus, Eutamias cf. quadrivittatus indicated that the bone was of a chipmunk of the genus Eutamias, but that identification as the species E. quadrivittatus was not positive. Although such determinations were primarily on a morphological basis, geographical considerations were taken into account at times, as were positive identifications of other skeletal elements in the same group of bones.

A query mark (as E. ? quadrivittatus) indicated extreme uncertainty at the taxonomic level of the following word. It might best be described as a reasonable guess, not contradicted by morphological or distributional data. Where considered helpful, these symbols have been carried over to this report.

Other features recorded were the name of the skeletal element; age, as judged by toothwear when possible and by such features as fusion of epiphyses when teeth were absent; burned bone, indicating use by the Indians or presence within a structure when the latter was burned; and, where seemingly useful, whether the element was from the right side or left. By use of the latter information, along with non-paired bones, etc., the minimum possible number of individuals of each species within a feature was calculated.

Owing to limitations of time, many specimens could not be identified to as low a taxonomic level as possible. Studies on many, if not all, polytypic genera would allow identification to species of many more skeletal elements than is now possible. Such studies as time allowed were carried out on

taxa thought likely to be most productive for this study.

Following animal identification and recording of such on site worksheets, the sites and features within the sites, along with the identifications, were arranged in chronologic order by Eddy. Much interpretation is based on comparisons of different cultural phases rather than on the basis of absolute time, since the former are less likely to be changed with further study of the archaeology (see Appendix A).

Interpretation of the data was, in part, by subjective judgments based on personal knowledge of the present ecologic and geographic distributions of the concerned species in and near the study area (Harris, 1963) and elsewhere in the Southwest. Personal knowledge was supplemented by information from biological literature. The data were studied particularly in regard to geographic shifts within the Reservoir District and to changes through time.

Statistical methods were also used. For each archaeological phase and phase-transition period, the minimum number of mammalian individuals (exclusive of Homo and Canis) was figured for each geographic section of the Reservoir area and for all such sections. The minimum number of individuals for each species that might be expected to reveal environmental changes was found for each such unit also. Total minimum numbers for each phase and geographic section are shown in Table I.

TABLE I

MINIMUM NUMBER OF INDIVIDUALS BY GEOGRAPHIC SECTION AND CULTURAL PHASE

PHASE / SECTION	Los Pinos	Los Pinos-Sambrito	Sambrito	Rosa	Rosa-Piedra	Piedra	Piedra-Arboles	Arboles	Navajo	Lucero	TOTAL OCCURRENCES
Sandoval	-	-	126	2	-	-	-	5	-	-	133
Piedra River	-	-	-	33	16	36	4	9	-	-	98
Rosa	-	-	47	4	42	70	30	21	13	-	227
Pine River B	83	-	-	-	-	-	-	-	-	-	83
Bancos	12	-	17	17	-	142	3	58	21	1	271
Pine River A	27	17	2	-	-	-	-	-	44	-	90
La Jara	-	-	-	-	-	-	-	-	17	-	17
Frances	-	-	-	56	-	88	-	-	1	-	145
TOTAL OCCURRENCES	122	17	192	112	58	336	37	93	96	1	1064

Given the total minimum number of individuals from each unit and the minimum number of individuals for each species for the same unit, the composition of the recovered fauna could be calculated. Thus, changes in composition between geographic sections or between phases (time-cultural levels) could be observed. Such changes could be the result: 1) of chance; 2) of bias in deposition, preservation, or recovery; or 3) of meaningful environmental change.

It should be emphasized that such figures as the above do not reflect accurately the total fauna present at the time of deposition. However, barring major changes in hunting emphasis, etc., by the Indians, or of using significantly different habitats as home sites, the bias in deposition should be similar for all times and geographic sections, allowing comparisons between units.

Again, it might be suspected that differential preservation has occurred, for example, that small animals might be preserved less well in older sites, where ground water and chemical action have had longer to work on fragile bone. No evidence supporting such a thought has come to light.

Perhaps most serious is recovery bias. A number of different archaeologists and laborers were involved in excavation. Moreover, changes in excavation timetables and in availability of labor and mechanized equipment have resulted in changes in types and quantities of bones recovered. In a project of this type, such bias cannot be eliminated; it can only be recognized as being present, and due care must be taken in interpretation.

Two samples containing different proportions of individuals displaying a certain trait may be examined by a X^2 test to determine the probability that the samples differ by chance alone. If the probability (p) is low, then some other reason for the observed differences should be sought. In most biological sciences, a value for p of 0.05 (5% level) or less is considered significant. Such a X^2 test was applied to many of the samples in this study and this procedure forms part of the basis for interpretation. In such analysis a cf'ed individual was considered as belonging to that species; a quieried individual was not included in the calculations. Some general identifications (e.g., Artiodactyla) were used in computing the minimum numbers of individuals present, but do not appear on identification charts.

In Figure 2, the identifications are recorded to time and phase level in charts arranged according to geographic section. Each site is designated by a number from the Museum of New Mexico survey catalog and is prefixed by the letters LA. Also given are the type of structure of each feature, the phase or phases represented in each feature, the date or time-range represented, vertebrates identified, and general remarks. Of these items, I am responsible for the identifications and any remarks on the fauna; the remainder of the data is the responsibility of Eddy.

A number in parentheses following an identification refers to the minimum number of individuals known to be present; in the absence of parentheses, the number is to be understood as one. Where elements identified to a given genus are present, and one or more can be identified to species, the specific name, only, is given, unless for obvious reasons some of the remaining elements could not belong to the specifically identified individuals. Then, the generic name (as, Sylvilagus sp.) is given, also.

The data originally were plotted according to the archaeologist's specimen bag numbers. Each such bag usually represented a different feature, level, or area. In determining minimum numbers of individuals from a given unit, each specimen bag has been considered separately. Thus, occasionally excess numbers of individuals may be recorded where disturbances have occurred; such bias seems less than if such calculations were based only on the lumped sample from a larger unit,

in which case under-representation would be serious.

In several taxa, an assumption is made as to species when the following conditions are met: (1) all specifically identifiable remains from the study area are of a single species, (2) morphological features do not contradict such identification, and (3) only a single species of the genus is expectable in the area (or differences between expectable species of the genus are so great as to preclude confusion). Treated in this way are Odocoileus hemionus, Dipodomys ordi, Marmota flaviventris, Cynomys gunnisoni, and Onychomys leucogaster. In addition, fragments that are identifiable to a genus that has only one known species expectable are listed as that species. Castor canadensis is an example of such.

An additional comment is necessary. Some of the specimens listed as Microtus longicaudus can be identified to this species, but others can only be shown to differ from M. pennsylvanicus and M. montanus. Thus, there remains a possibility that M. mexicanus (known from Mesa Verde, Colorado to the north and west) is included in such material. That possibility, however, appears to be remote.

Fig. 2. Identification of faunal remains by geographic section and archaeological site.

FRANCES SECTION

LA 4065/ Rock Shelter/ late Rosa Phase/ ca. A.D. 850
Sceloporus sp. (2); Sceloparus undulatus (2); Sylvilagus sp. (6); S. auduboni (2); S. cf. auduboni; Citellus variegatus (2); cf. C. variegatus or C. gunnisoni; Thomomys sp. (3); T. bottae; T. cf. bottae (2); Dipodomys ordi; Castor canadensis (2); cf. Peromyscus; cf. Peromyscus maniculatus; Neotoma sp. (6); Vulpes cf. macrotis; cf. Canis; ? Urocyon cinereoargenteus; cf. U. cinereoargenteus; O. hemionus (5); cf. O. hemionus; cf. Antilocapra americana; A. americana; cf. Ovis-Capra; O. canadensis; Ovis aries-Capra hirsuta.

LA 3427/ Surface House/ Piedra Phase/ ca. A.D. 900
cf. Neotoma, cf. Canid.

Pit house/ Piedra Phase/ ca. A.D. 900
Sylvilagus auduboni (2); S. ? nuttalli; Sylvilagus sp. (11); Lepus sp.; Citellus variegatus; cf. C. variegatus (3); C. variegatus or C. gunnisoni (3); cf. C. variegatus or C. gunnisoni (3); Thomomys sp. (5); Castor canadensis (6); Neotoma sp. (3); Peromyscus sp.; Ondatra zibethicus; cf. Felis concolor; Lynx cf. rufus; Cervus canadensis or Odocoileus hemionus.

Pit house/ early Piedra Phase/ A.D. 850 - 900
Sylvilagus auduboni (2); Sylvilagus sp. (5); Lepus sp. (6); Citellus cf. leucurus; C. variegatus or C. gunnisoni; cf. C. variegatus or C. gunnisoni (3); Cynomys gunnisoni (3); Thomomys sp.; Castor canadensis (2); Neotoma sp. (3); Erethizon dorsatum; cf. E. dorsatum; cf. Canis familaris; ? Vulpes; Bassariscus astutus; Lynx cf. rufus; Odocoileus hemionus; Antilocapra americana; Ovis canadensis.

Pit house/ Rosa Phase/ ca. A.D. 800
Sylvilagus cf. auduboni; Sylvilagus sp.; Lepus sp. (2); C. variegatus or C. gunnisoni.

Pit house/ Rosa Phase/ ca. A.D. 800
Sylvilagus auduboni; Sylvilagus sp.; Neotoma sp.; Cervus canadensis.

Pit house/ late Rosa Phase/ A.D. 800 - 900/ Mixed provenience
Cervus canadensis

Trash mound/ Rosa Phase/ ca. A.D. 800
Castor canadensis; Odocoileus hemionus.

LA 4072/ Rock shelter (walled up)/ Gobernador Phase/1700 - 1775/ Hester and Shiner, 1963, Chap. III
cf. Ovis aries-Capra hirsuta.

PINE RIVER SECTION A

LA 3430/ Exterior pit/ indeterminate Navajo Phase/ 1550 - 1775
cf. Bufo (2); Bufo cf. woodhousei; Sylvilagus sp.

Ring structure/ Los Pino-Sambrito Phase/ ca. A.D. 400
Sylvilagus auduboni (3); S. nuttalli; S. cf. nuttalli (2); Sylvilagus sp.; Sylvilagus or Lepus; C. variegatus; or C. gunnisoni (2); Citellus variegatus; Thomomys bottae (2); Equus cf. caballus; Odocoileus hemionus; cf. O. hemionus (2).

Non-ring structure/ Los Pinos Phase/ Radiocarbon date: A.D. 117 ± 131
Thomomys bottae; Odocoileus hemionus.

LA 4298/ Surface structure/ Navajo Period/ 1550-1775 / Hester and Shiner, 1963, Chap. IV
Sylvilagus sp.

Rock shelter/ Gobernador Phase/ 1700 - 1775
Sceloporus undulatus; Sylvilagus auduboni; Castor canadensis; Neotoma cf. albigula; Taxidea taxus.

Rock shelter/ Dinetah Phase (?)/ 1550 - 1700
Sceloporus undulatus; Sylvilagus auduboni; Sylvilagus sp. (4); Citellus variegatus (2); C. variegatus or C. gunnisoni; Neotoma sp. (6); Odocoileus hemionus; cf. Ovis canadensis.

Rock shelter/ Dinetah Phase/ 1550 - 1700
Sceloporus undulatus; Sylvilagus sp.; Citellus variegatus; Neotoma sp. (2); Ovis or Odocoileus.

Rock shelter/ (?)/ (?)
Sceloporus sp.; Sylvilagus sp.

Rock shelter/ Sambrito Phase (?)/ A.D. 400 - 700
Sylvilagus sp.; Microtus longicaudus.

LA 4299/ Rock shelter/ Gobernador Phase/ 1700-1750/ Hester and Shiner, 1963, Chap. IV
Odocoileus hemionus; cf. O. hemionus.

LA 4294/ Rock shelter/ Gobernador Phase/ 1700 - 1750/ Hester and Shiner, 1963, Chap. IV
Sylvilagus nuttalli; Sylvilagus sp. (2); C. variegatus or C. gunnisoni; Cynomys gunnisoni; Castor canadensis; Neotoma sp. (4); cf. Neotoma stephensi; Odocoileus hemionus.

LA 4289/ Ring structures/ Los Pinos Phase/ A.D. 1 - 400/ Eddy, 1961
Sylvilagus sp. (3); Thomomys sp. (3); Peromyscus sp. (2); cf. Canis; Cervus or Odocoileus; Odocoileus hemionus.

Non-ring structures/ Los Pinos Phase/ A.D. 1 - 400
Sylvilagus sp. (3); Sylvilagus nuttalli; cf. C. variegatus or C. gunnisoni (2);Cynomys gunnisoni; Thomomys sp. (2); Thomomys bottae (2); Neotoma cf. albigula; Odocoileus hemionus (2); Ovis canadensis.

LA 3021/ Rock shelter/ Gobernador Phase/ A.D. 1700 - 1775
Sylvilagus sp.; Neotoma sp.

PINE RIVER SECTION B

LA 4269/ Ring structures/ Los Pinos Phase/ A.D. 1 - 400
cf. Odocoileus; ? Ovis canadensis.

Non-ring structures/ Los Pinos Phase / A.D. 1 - 400
Sylvilagus sp. (3); cf. Lepus; Castor canadensis; Canis sp.; Odocoileus hemionus (2); Bos, Bison or Ovis.

Exterior pit/ Los Pinos Phase/ A.D. 1 - 400
Bufo cf. woodhousei; Sylvilagus cf. auduboni (4); S. cf. nuttalli (2); Sylvilagus sp. (7); Citellus variegatus (3); Cynomys gunnisoni (3); C. variegatus or C. gunnisoni (5); Thomomys sp. (3); Thomomys bottae (6); Reithrodontomys cf. megalotis; Dipodomys ordi; cf. Perognathus; Perognathus cf. apache; cf. Onychomys or Peromyscus; Peromyscus sp. (2); Castor canadensis; Onychomys leucogaster (2); Neotoma sp. (7); Neotoma cf. mexicana (poss. N. cinerea) (2); Microtus sp. (3); Microtus (not M. pennsylvanicus) (2); Microtus longicaudus (7).

Test trench / ? / ? /
Sylvilagus sp.; Odocoileus hemionus.

LA 4257/ Ring structures/ Los Pinos Phase/ A.D. 1 - 400/ Eddy, 1961, Fig. 72
Lepus sp.; Odocoileus hemionus; Odocoileus or Ovis.

Exterior pit/ Los Pinos Phase /A.D. 1 - 400
Thomomys bottae.

LA JARA SECTION

LA 4314/ Surface house/ Gobernador Phase / A.D. 1700 - 1775/ Hester and Shiner, 1963, Chap. III
Sylvilagus sp.; Neotoma sp.

LA 4411/ Rock shelter/ indeterminate Navajo Phase/ A.D. 1550 - 1775/Hester and Shiner, 1963, Chap. III
Sceloporus sp.; Sylvilagus auduboni (2); Sylvilagus sp.; Neotoma sp. (4); cf. Lynx; Odocoileus hemionus; cf. Antilocapra americana; cf. Ovis aries-Capra hirsuta.

LA 4331/ Surface house/ Gobernador Phase/ A.D. 1700 - 1775/ Hester and Shiner, 1963, Chap. III
Sylvilagus sp.; Citellus variegatus; Odocoileus hemionus

BANCOS SECTION

LA 4380/ Homestead farm/ Lucero Phase/ A.D. 1900's
Ovis aries - Capra hirsuta

Kivas/ early Arboles Phase/ A.D. 950 - 1000
Sylvilagus auduboni (2); S. cf. auduboni; Sylvilagus sp. (3); Lepus sp. (3); Marmota flaviventris; Cynomys gunnisoni; Thomomys sp.; Thomomys bottae; cf. Canis; Canis cf. Odocoileus hemionus.

Refuse area/ early Arboles Phase/ A.D. 950 - 1000
Ochotona princeps; Sylvilagus auduboni; Sylvilagus sp. (2); Lepus sp. (4); Marmota flaviventris (2); Citellus variegatus (2); C. variegatus or C. gunnisoni; Tamiasciurus hudsonicus; Neotoma sp.; Canis cf. familiaris.

Surface house/ early Arboles Phase/ A.D. 950 - 1000
Sylvilagus sp. (2); Ovis canadensis.

Surface house/ early Arboles Phase / ca. A.D. 950
Sylvilagus sp. (2); Marmota flaviventris; Thomomys sp.; ? Canis lupus; Odocoileus or Cervus.

Surface house/ early Arboles Phase (?)/ ca. A.D. 950
Sylvilagus sp.

Pit house/ early Arboles Phase/ca. A.D. 950
Scaphiopus sp.; Sylvilagus auduboni; Sylvilagus sp.; C. variegatus or C. gunnisoni; cf. Cervus; cf. Odocoileus.

Pit house/ early Arboles Phase (?)/ ca. A.D. 950
Sylvilagus sp.; Lepus sp.; Peromyscus maniculatus.

Pit house/ Piedra Phase / ca. A.D. 950/ Tree-ring date: 893 v.
Lepus sp.; Marmota flaviventris; cf. Canis.

Surface house/ late Piedra Phase/ A.D. 950/ Tree-ring date: 879 ± v.
Sylvilagus sp.; Marmota flaviventris; Thomomys bottae; Canis cf. familiaris; Cervus canadensis (2); Ovis, Capra, or Odocoileus; cf. Odocoileus hemionus (2); Ovis canadensis.

Surface house/ late Piedra Phase (?) / ca. A.D. 950
Lepus sp.; Canis sp.

Pit house/ late Piedra Phase/ A.D. 900 - 950
Sylvilagus sp. (2); Lepus sp.; Cynomys gunnisoni; cf. Thomomys; Microtus longicaudus; Odocoileus or Cervus.

Pit house/ late Piedra Phase / ca. A.D. 950/ Tree-ring date: 893 vv
Cynomys gunnisoni; C. variegatus or C. gunnisoni; Ovis canadensis.

Pit house/ late Piedra Phase/ A.D. 900 - 950
Sylvilagus auduboni; S. cf. auduboni; Sylvilagus sp. (2); C. variegatus or C. gunnisoni (2); Lepus sp. (2); Thomomys sp.; Onychomys leucogaster; Neotoma sp.; ? Odocoileus; Antilocapra americana; cf. Ovis canadensis.

Pit house/ late Piedra Phase/ A.D. 900 - 950/ Tree-ring dates: 892 r, 880 vv, 893 vv, 892 r
Sylvilagus auduboni; Sylvilagus sp.; Lepus sp. (2); C. variegatus or C. gunnisoni; Cynomys gunnisoni; Thomomys sp.; Neotoma sp.; Bos, Bison, or Cervus; Ovis canadensis.

Surface house/ late Piedra Phase/ A.D. 900 - 950
Lepus sp.; Odocoileus or Cervus.

Pit house/ late Piedra Phase/ A.D. 900 - 950/ Tree-ring dates: 892 r, 881 r, 890 r, 892 vv, 892 r, 892 r, 891 r
Canis cf. familiaris; cf. Canis or Taxidea.

Refuse area/ late Piedra Phase/ A.D. 900 - 950
Castor canadensis; Canis cf. familiaris; C. cf. latrans.

Surface house/ late Piedra Phase/ A.D. 900 - 950
Sylvilagus sp.; Thomomys sp. (2); Thomomys bottae (2)

Exterior pit/ late Piedra Phase/ A.D. 900 - 950
Sylvilagus sp.

Pit house/ late Piedra Phase/ A.D. 900 - 950/ House fill is somewhat mixed with earlier Rosa Phase ceramic types. Tree-ring dates: 900 r, 884 v.

Rana pipiens; Rana cf. pipiens; Sylvilagus auduboni (3); S. cf. auduboni; Sylvilagus sp. (4); Lepus sp. (4);Marmota flaviventris (2); Citellus variegatus (3); Citellus variegatus or C. gunnisoni; Cynomys gunnisoni; Thomomys sp.; Thomomys bottae; Dipodomys ordi; Castor canadensis (2); Neotoma sp; Microtus longicaudus; Canis familiaris (2); Canis cf. familiaris; Canis cf. latrans; cf. Mustela frenata; Lynx cf. rufus; cf. Odocoileus; Ovis canadensis; cf. O. canadensis; cf. Ovis or Odocoileus.

Surface house/ Piedra Phase ca. A.D. 900/ mixed sample
Sylvilagus sp.; Sylvilagus nuttalli; Dipodomys ordi.

Surface house (cobble paving?)/ Piedra Phase/ ca. A.D. 900
Ovis canadensis.

Pit house (wall bin) / Piedra Phase (?)/ ca. A.D. 900
Sylvilagus sp.; Lepus sp.; Ovis canadensis.

Test trench/ Piedra Phase/ ca. A.D. 900
Lepus sp.; cf. Odocoileus; Antilocapra americana.

Pit house/ Piedra Phase ca. A.D. 900
Sylvilagus sp. (2); ? Canis; cf. Odocoileus.

Surface house/ Piedra Phase/ ca. A.D. 900
cf. Cervus canadensis; Cervus or Odocoileus.

Surface house/ early Piedra Phase/ A.D. 850 - 900
Sylvilagus sp. (2); S. auduboni; Sylvilagus nuttalli; Lepus sp.; cf. Lepus americanus; Marmota flaviventris; cf. Castor canadensis; Canis sp. (2); cf. Canis lupus (2); cf. Canis latrans or familiaris; C. cf. latrans; Taxidea taxus; Odocoileus hemionus; Odocoileus or Cervus; cf. Procyon lotor.

Test trench/ early Piedra Phase/ A.D. 850 - 900
Canis sp.

Surface house/ early Piedra Phase/ ca. A.D. 850/ Tree-ring dates: 887 vv, 885 vv, 858 r
Lepus sp. (2); Cervus or Odocoileus; cf. Odocoileus hemionus; ? Antilocapra or ? Ovis; Ovis canadensis; cf. Cervus canadensis.

Surface house/ late Rosa Phase/ ca. A.D. 850/ Tree-ring date: 847 r
Sylvilagus sp.; Cynomys gunnisoni.

Surface house/ late Rosa Phase/ A.D. 800 - 850
Sylvilagus auduboni; Thomomys sp.; Ovis canadensis.

Pit house/ early Rosa Phase/ A.D. 700 - 800
Sylvilagus sp. (2); Lepus sp.; C. variegatus or C. gunnisoni; Thomomys sp.; Thomomys bottae.

Exterior pit/ Sambrito Phase/ A.D. 400 - 700
Scaphiopus sp.; Bufo sp.; Sylvilagus sp.; C. variegatus or C. gunnisoni; Perognathus sp.; Peromyscus or Reithrodontomys; Onychomys leucogaster; Microtus longicaudus (2).

Pit house/ ? / ? / Younger than early Arboles Phase
Sylvilagus auduboni (4); Sylvilagus nuttali; Sylvilagus sp.; Lepus sp. (3); Citellus variegatus (2); Cynomys gunnisoni; cf. C. variegatus or C. gunnisoni; Thomomys sp.; Peromyscus sp.; Neotoma sp. (2).

Test trench/ Rosa Arboles Phase (?)/ A.D. 850 - 1000/ mixed collection
Sylvilagus nuttalli; Lepus sp.; C. variegatus or C. gunnisoni; Thomomys sp.

LA 3047/ Rock shelter/ indeterminate Navajo Phase/ A.D. 1550 - 1775
Sylvilagus auduboni (2); S. cf. auduboni; S. nuttalli; S. cf. nuttalli; Sylvilagus sp. (3); cf. Citellus; Neotoma sp. (2); Neotoma stephensi (2); N. cf. mexicana; Erethizon dorsatum; Odocoileus hemionus or Ovis canadensis; O. hemionus (3); Ovis-Capra; cf. Ovis-Capra.

LA 4384 / Ring structure/ Los Pinos Phase/ A.D. 1 - 400
Sylvilagus sp. (2).

LA 4385/ Refuse area/ Rosa Phase/ ca. A.D. 800
Sylvilagus cf. auduboni.

Pit house/ Rosa Phase (?)/ ca. A.D. 800 (?)
Sylvilagus auduboni; Sylvilagus sp.

Surface house (?) / Rosa Phase / ca. A.D. 800
Antilocapra americana

LA 5843/ Ring structure / Los Pinos Phase / A.D. 1 - 400
Sylvilagus nuttalli; Thomomys sp.

Non-ring structure/ Los Pinos Phase/ A.D. 1 - 400
Sylvilagus cf. auduboni; S. cf. nuttalli; Sylvilagus sp. (2); Thomomys sp.;Castor canadensis; cf. Odocoileus (2)

LA 4363/Surface house/ Arboles Phase/ ca. A.D. 1000
Sylvilagus sp.; Lepus sp.; Castor canadensis; Odocoileus hemionus; Ovis canadensis.

Alluvial profile/ early Rosa Phase/ A.D. 700 - 800
Sylvilagus sp.

Alluvial profile/ Sambrito Phase/ A.D. 400 - 700
Sylvilagus sp. (2); Lepus sp.; Castor canadensis; Taxidea taxus; Lynx cf. rufus; Odocoileus hemionus.

Exterior pit/ Sambrito Phase/ A.D. 400 - 700
Sylvilagus sp.; cf. Thomomys.

ROSA SECTION

LA 4245/ Pit house, Feature 3/ Late Rosa-Early Piedra Phase/ A.D. 800-900/Evans and Foley, 1961/Fig.26.
Taxidea taxus.

Test trench (surface)/ late Rosa-early Piedra Phase/ A.D. 800 - 900
Ovis aries-Capra hirsuta.

LA 4247/ Pit house/ late Rosa-early Piedra Phase/ A.D. 800 - 900/ McVickers and Lenington, 1961, Fig. 34
Bufo woodhousei; Sylvilagus auduboni (2); Sylvilagus sp. (3); Lepus sp. (4); Cynomys gunnisoni; Thomomys cf. Bottae; Thomomys sp. (2); Marmota flaviventris; Perognathus sp.; ? Peromyscus; Onychomys or Peromyscus; Neotoma sp. (3); Ondatra zibethicus; cf. Canis familiaris; Taxidea taxus.

LA 4242/ Pit house/ early Piedra Phase/ A.D. 880 $\pm$ 30/ Greminger and Cox, 1961, Fig. 12
Sylvilagus auduboni; Sylvilagus sp. (5); Lepus sp. (2); Citellus variegatus; Thomomys sp.; Castor canadensis (3).

LA 4195/ Hogan/ Gobernador Phase/ A.D. 1700 - 1775/ Dittert, Eddy and Dickey, 1963
Sylvilagus cf. auduboni; Sylvilagus sp. (2); Thomomys sp.; Castor canadensis; Odocoileus hemionus.

Pit house/ early Arboles Phase/ A.D. 975 - 1000
Sylvilagus sp.; cf. Canis.

Pit house/ early Arboles Phase/ A.D. 950 - 1000
C. variegatus or C. gunnisoni; cf. Canis; Cervus canadensis; Cervus or Odocoileus; cf. Odocoileus.

Surface house/ early Arboles Phase/ A.D. 950 - 1000
Sylvilagus sp.; Antilocapra americana; Ovis canadensis.

Exterior pit/ early Arboles Phase/ A.D. 950 - 1000
Sylvilagus auduboni.

Exterior pit/ late Piedra Phase/ A.D. 900 - 1000
cf. Canis familaris.

Surface house/ late Piedra Phase/ A.D. 900 - 1000
Thomomys bottae (2); Perognathus sp.; Dipodomys ordi; cf. Canis.

Exterior pit/ early Arboles Phase/ A.D. 950 - 1000
Thomomys bottae; Neotoma cf. mexicana; cf. Canis.

Test trench/ late Piedra - early Arboles Phase / A.D. 925 - 975
Sylvilagus auduboni; Canis sp.; Odocoileus hemionus.

Exterior pit/ late Piedra - early Arboles Phase/ A.D. 925 - 1000
cf. Odocoileus.

Surface house/ late Piedra - early Arboles Phase/ A.D. 900 - 1000
Thomomys sp.; Canis sp.

Pit house/ Piedra - Arboles Phase/ A.D. 950 - 975
Thomomys sp.; Castor canadensis; cf. Canis.

Pit house/ early Arboles Phase/ A.D. 950 - 975
Bufo sp.; Lepus sp.; cf. Ovis canadensis.

Pit house/ Arboles Phase/ A.D. 950 - 1000
Sylvilagus sp.; Marmota flaviventris; Ovis canadensis.

Pit house/ late Piedra - early Arboles Phase/ A.D. 975 - 1000
Microtus pennsylvanicus; Canis cf. familiaris.

Pit house/ late Piedra - early Arboles Phase/ A.D. 925 - 975
Sylvilagus sp.; Lepus sp. (2); Thomomys bottae; Canisfamiliaris; cf. Ovis canadensis.

Pit house/ late Piedra - early Arboles Phase/ A.D. 900 - 975
Thomomys cf. bottae; cf. Odocoileus.

Pit house/ late Piedra - early Arboles Phase/ ca. A.D. 950
C. variegatus or C. gunnisoni; cf. Marmota; Canis familiaris; Ovis canadensis.

Test trench/ late Piedra - Arboles Phase/ ca. A.D. 950
O. canadensis or Odocoileus hemionus; Ovis canadensis.

Test trench/ early Arboles Phase/ ca. A.D.950
Sylvilagus sp. (2); Castor canadensis; Odocoileus hemionus.

Exterior pit/ late Piedra - early Arboles Phase / ca. A.D. 950
Sylvilagus sp. (3); Mustela cf. frenata; Thomomys bottae.

Pit house/ late Piedra Phase/ A.D. 925 - 950
Cervus canadensis.

Pit house/ late Piedra Phase/ A.D. 900 - 950
Sylvilagus sp. (4); Lepus sp. (2); Thomomys sp.; Castor canadensis.

Pit house/ Piedra-Arboles Phase/ A.D. 950
cf. Ovis-Capra.

Test trench/ early Piedra Phase/ A.D. 900 - 950
Sylvilagus sp.; Lepus sp.; cf. Odocoileus.

Exterior pit/ late Piedra Phase/ A.D. 900 - 950
Sylvilagus sp.

Surface house/ early Piedra Phase/ A.D. 875 - 950
Sylvilagus sp. (2); Lepus sp.; Thomomys bottae; Castor canadensis; Canis cf. familiaris; Cervus or Odocoileus; Odocoileus hemionus; Odocoileus or Ovis.

Surface house/ early Piedra Phase/ A.D. 850 - 925
Sylvilagus sp.

Pit house/ Piedra Phase/ A.D. 875 - 925
Castor canadensis; Canis cf. familiaris.

Pit house/ Piedra Phase/ A.D. 875 - 950
Sylvilagus auduboni (2); Sylvilagus sp.; Lepus sp.; Thomomys bottae (2); cf. Ovis canadensis.

Test trench/ Piedra Phase/ A.D. 850 - 950
Odocoileus hemionus; Odocoileus or Cervus.

Pit house/ Piedra - early Arboles Phase/ A.D. 875 - 975
Sylvilagus sp.; Thomomys bottae; Odocoileus hemionus; cf. Ovis canadensis.

Pit house/ Piedra Phase/ A.D. 850 - 950
Sylvilagus sp.; Thomomys sp.; Martes americana.

Pit house/ mixed late Rosa to early Arboles Phase/ A.D. 800 - 950
Sylvilagus sp. (2); Thomomys bottae; Neotoma sp.

Exterior pit/ late Piedra Phase/ A.D. 900 +
Sylvilagus sp.; Lepus sp.; cf. C. variegatus or C. gunnisoni; Thomomys bottae (3); Canis cf. familiaris.

Pit house/ early Piedra Phase/ A.D. 875 - 900
Sylvilagus auduboni; Sylvilagus sp.; Odocoileus or Cervus; Ovis canadensis.

Test trench/ early Piedra Phase/ A.D. 875 - 900
C. variegatus or C. gunnisoni.

Pit house/ late Rosa - early Piedra Phase/ A.D. 825 - 900
Thomomys bottae; Canis sp.; C. familiaris; cf. C. familiaris; Lynx cf. rufus; Cervus canadensis; Odocoileus hemionus; cf. Odocoileus; Ovis canadensis or Odocoileus; cf. Ovis; cf. O. canadensis.

Test trench/ Rosa - early Piedra Phase/ ca. A.D. 850
cf. Canis; Ovis canadensis.

Pit house/ late Rosa - early Piedra Phase/ ca. A.D. 850
Neotoma sp.; cf. Canis familiaris; cf. Odocoileus.

Pit house/ late Piedra Phase/ A.D. 900 - 950
Sylvilagus sp.; Tamiasciurus hudsonicus; Odocoileus hemionus.

Pit house/ Rosa - Piedra Phase
Sylvilagus sp.; cf. Lepus americanus; Canis cf. familiaris; Odocoileus hemionus.

Test trench/ late Rosa - early Piedra Phase/ A.D. 800 - 900
Tayassu sp.

Test trench/ Rosa Phase/ ca. A.D. 800 - 850
Thomomys bottae; Castor canadensis.

Exterior pit/ late Rosa-early Piedra Phase/ A.D. 800-850
cf. Citellus variegatus; Odocoileus hemionus.

Exterior pit/ late Rosa Phase/ A.D. 800 - 850
Cervus canadensis; cf. Odocoileus.

Pit house/ Rosa Phase/ A.D. 750 - 850
? Canis

Pit house/ Sambrito Phase/ ca. A.D. 700
Sylvilagus sp. (2); Lepus or Sylvilagus; Lepus sp.; Odocoileus hemionus; cf. O. hemionus.

Pit house/ Sambrito Phase/ A.D. 700 +
Lepus sp.; cf. Odocoileus hemionus (2)

Pit house/ Sambrito Phase/ A.D. 400 - 700
Sylvilagus auduboni (2); cf. Sylvilagus; Sylvilagus sp. (2); Lepus sp.; Thomomys sp.; T. bottae; Peromyscus sp.; ? Canis; cf. Odocoileus; Odocoileus hemionus (3).

Exterior pit/ Sambrito Phase/ A.D. 400 - 700
Sylvilagus cf. auduboni.

Exterior pit/ Sambrito Phase/ A.D. 400 - 700
Sylvilagus auduboni; Sylvilagus cf. auduboni; Sylvilagus sp. (2); Lepus sp.; Marmota flaviventris; Thomomys sp. (3); Thomomys bottae (3); Reithrodontomys sp.; ? Peromyscus; cf. Canis; C. cf. latrans; C. familiaris; C. cf. familiaris (3); cf. C. familiaris; Canis sp.; Odocoileus hemionus; cf. O. hemionus; Ovis canadensis.

Test trench/ late Piedra Phase/ ca. A.D. 925/ (? 2 periods represented)
Odocoileus hemionus.

Pit house/ early Rosa-Piedra Phase / A.D. 700 - 775 (early), 900/ Mixed
Sylvilagus sp; cf. Canis.

LA 4199/ Test trench/ Gobernador Phase/ A.D. 1700 - 1775 / Hester and Shiner, 1963, Chap. II.
Ovis canadensis.

Hogan/ Gobernador Phase/ A.D. 1700 - 1775
Sylvilagus sp. (3); Lepus sp.; Thomomys sp.

Ramada/ Gobernador Phase/ A.D. 1700 - 1775
C. variegatus or C. gunnisoni.

LA 3035/ Pit house/ Sambrito Phase/ A.D. 400 - 700
Sylvilagus cf. auduboni; Sylvilagus sp. (2); Cynomys gunnisoni; Thomomys sp.; Lynx cf. rufus.

PIEDRA RIVER SECTION

LA 4088/ Pit house/ Rosa Phase/ A.D. 800 - 825
Sylvilagus sp. (2); Lepus sp.; Dipodomys ordi; Canid.

Test trench/ Rosa Phase/ A.D. 800 - 825
Thomomys cf. bottae.

LA 4086 / Surface house/ early Arboles Phase/ A.D. 950 - 1000
Sylvilagus sp.; Thomomys sp.; Cervus or Odocoileus.

Pit house/ early Arboles Phase/ A.D. 950 - 1000
Sylvilagus sp.; Cervus or Odocoileus; Odocoileus hemionus.

Surface house/ late Piedra-early Arboles Phase/ ca. A.D. 950
Sylvilagus cf. auduboni; cf. Cervus.

Subfloor pit/ early Arboles Phase/ A.D. 950 - 975/ Tree-ring date: 858 vv
? Turtle; Sylvilagus auduboni; Dipodomys ordi.

Test trench/ late Piedra (?) Phase/ A.D. 900 - 975 (?)
Canis cf. familiaris.

Pit house/ Piedra Phase/ A.D. 900 (-)/ Tree-ring dates: 881 r, 888 r
Lepus sp.; Thomomys sp.; Erethizon dorsatum; Cervus canadensis.

Pit house/ Piedra Phase ca. A.D. 900/ Tree-ring dates: 881 r, 881 rB, 881 r, 881 vvB, 880 vv, 881 rB, 881 B, 881 B, 881 rB.
Sylvilagus auduboni; Thomomys cf. bottae; cf. Odocoileus; Ovis canadensis.

Pit house/ mixed late Rosa-Piedra Phase/ ca. A.D. 850 - 925 / Fill is mixed and probably washed in.
Sylvilagus sp.; Sylvilagus cf. auduboni; S. cf. nuttali; Lepus sp. (4); Cynomys gunnisoni; C. variegatus or C. gunnisoni; Thomomys sp.; Dipodomys ordi; Peromyscus sp.; Neotoma cinerea; Cervus canadensis; Ovis-Capra; cf. Ovis-Capra; ? Canid.

Test trench/ late Rosa Phase/ A.D. 825 - 850
cf. Ovis-Capra.

Test trench/ late Rosa Phase (?)/ ca. A.D. 825 (?)
Sylvilagus cf. auduboni; C. variegatus or C. gunnisoni; cf. Dipodomys ordi; Ovis-Capra.

Surface house/ late Rosa Phase (?)/ ca. A.D. 825 (?)
Ovis-Capra.

Test trench/ late Rosa Phase/ ca. A.D. 825
Ovis canadensis.

Surface house/ late Rosa Phase/ ca. A.D. 825
cf. Canis lupus.

Stockade/ late Rosa-early Arboles Phase/ A.D. 800-1000
Sylvilagus nuttalli

LA 4406/ Pit house/ early Piedra Phase/ A.D. 850 - 900/ Eddy, 1963, Table 7.
cf. Odocoileus.

Surface house/ early Piedra Phase/ A.D. 850 - 900
Sylvilagus auduboni; cf. Odocoileus.

LA 4408/ Pit house/ early Piedra Phase/ ca. A.D. 850/ Hester, 1963, Table 11
Lepus sp. (4); Marmota flaviventris; Castor canadensis; Ovis canadensis.

Pit house/ early Piedra Phase/ ca. A.D. 850
Sylvilagus sp. (2); Lepus sp.; Taxidea taxus; Ovis canadensis.

Pit house/ early Piedra Phase/ ca. A.D. 900
Sylvilagus sp.; Lepus sp.; Ovis canadensis.

Surface house/ early Piedra Phase (?)/ ca. A.D. 850 (?)
cf. Ovis canadensis.

Pit house/ Rosa Phase/ ca. A.D. 800
Sylvilagus sp. (4); S. auduboni; S. cf. nuttalli; Lepus sp. (6); cf. Marmota; Thomomys cf. bottae; Erethizon dorsatum; Ursus cf. americanus; Taxidea taxus; ? Odocoileus; cf. Odocoileus; Odocoileus or Ovis; cf. Antilocapra.

LA 4103/ Pit house/ late Piedra Phase/ A.D. 900 - 950/ Sciscenti, Dittert and Dickey, 1963
Sylvilagus sp. (2); Citellus variegatus; Odocoileus hemionus; Ovis canadensis; cf. O. canadensis.

Pit house/ late Piedra-early Arboles Phase/ A.D. 900 - 975
Sylvilagus sp.; Marmota flaviventris.

Surface rooms/ late Piedra Phase/ A.D. 900 - 975
Sylvilagus sp.; cf. Mustela frenata; cf. Odocoileus.

LA 4104/ Surface house/ early Arboles Phase/ A.D. 950 - 975 /Sciscenti, Dittert, and Dickey, 1963
Odocoileus hemionus.

SANDOVAL SECTION

LA 4169/ Exterior pit/ late Sambrito Phase/ A.D. 600 - 700 (?)
Sylvilagus auduboni; Sylvilagus nuttalli (4); S. ? nuttalli; Sylvilagus sp. (8); Lepus sp.; Sciurus aberti; Thomomys sp. (3); Thomomys bottae (3); Perognathus sp.; Dipodomys ordi (13); Castor canadensis (2); Peromyscus sp. (3); Onychomys leucogaster; Neotoma sp.; Microtus sp.; Microtus longicaudus; Erethizon dorsatum; Canis sp.; cf. familiaris; cf. familiaris (5); C. familiaris; Odocoileus hemionus (3).

Pit house/ late Sambrito Phase/ A.D. 600 - 700
Sylvilagus sp.; Odocoileus, Ovis or Cervus.

Exterior pit/ early Sambrito Phase/ A.D. 400 - 600
Sylvilagus sp.

Exterior pit/ Sambrito Phase (?)/ A.D. 400 - 700 (?)
Sylvilagus sp.; Odocoileus hemionus.

Exterior pit/ Sambrito Phase/ A.D. 400 - 700
Sylvilagus sp. (4); Lepus sp.; Citellus variegatus; C. variegatus or C. gunnisoni; Thomomys sp. (9); Thomomys bottae (3); Perognathus apache or flavus; P. apache; P. cf. apache; Dipodomys ordi (6); ?Dipodomys; Peromyscus sp. (3); cf. Peromyscus; Onychomys leucogaster (5); Onychomys or Peromyscus; Neotoma albigula (2); Microtus sp. (2); Microtus longicaudus; Canis; ? Canis; cf. Canis (2); C. familiaris (2); C. cf. familiaris (11); Cervus canadensis (2); Odocoileus hemionus (5); cf. Ovis canadensis.

LA 4169/ Exterior pit/ Sambrito (?) Phase/ A.D. 400 - 700 (?)
Sylvilagus cf. auduboni; Sylvilagus sp.; Thomomys sp.; Thomomys; Peromyscus sp. (5); Peromyscus or Reithrodontomys; cf. Peromyscus; Dipodomys ordi (2); Onychomys leucogaster; cf. O. leucogaster; Neotoma cinerea or mexicana; cf. Canis familiaris (2); Cervus canadensis.

Pit house/ mixed Piedra & Sambrito Phase/ ca. A.D. 900 & 600 - 700
Odocoileus hemionus.

Test trench/ early Arboles Phase/ ca. A.D. 1000
Lepus sp.; cf. Odocoileus.

Test trench (?)/ Rosa Phase/ ca. A.D. 800
Sylvilagus sp.; Ovis canadensis.

Test trench (?)/ ?/?/
Thomomys sp.; Ovis canadensis.

LA 4128/ Surface house/ Arboles Phase/ ca. A.D. 1050
Sylvilagus sp. (2); Neotoma sp.; Odocoileus hemionus.

SPECIES AND GENERIC ACCOUNTS

In this section an attempt has been made to point up certain facets of the results, and to discuss the pertinence of such facets to interpretation of the past environment. Taxa identified from the sites are considered, briefly or extensively as required. The amphibians and reptiles considered are arranged as in Schmidt (1953), and the mammals as in Hall and Kelson (1959).

• Anura

Many of the frog and toad remains have not been identified to genus or species, owing to lack of time. Most such remains are of the genus Bufo; the bulk of the others belong to the genera Rana and Scaphiopus.

• Scaphiopus sp. Spadefoot Toads.

Little significance can be ascribed to the presence of this genus in the study area. It is known, through its call, to occur today near Allison, Colorado, and has been collected south of the Reservoir area (Harris, 1963). In common with most other toads of the Southwest, it escapes drought and cold weather by burrowing into the ground. Since it commonly breeds in temporary rain pools, it may have used water standing in depressions left by abandoned aboriginal structures.

• Bufo sp. Common Toads.

Most of the remarks under the Scaphiopus account are also applicable here. This genus is represented commonly throughout the study area, and both north and south, by the species Bufo woodhousei. (A second species, B. boreas, occurs at somewhat higher altitudes.)

• Bufo woodhousei. Woodhouse's Toad.

This is the only species of Bufo definitely identified. (See remarks under the Bufo and Scaphiopus accounts.)

• Rana pipiens. Leopard Frog.

The leopard frog is less likely than the toads to occur naturally in sites, since it is more dependent on permanent water. The few remains may represent individuals collected for food, or by children as playthings.

Rana pipiens is not a sensitive indicator in the study area; it merely indicates the presence of permanent water in the vicinity.

• Chelonia. Turtles.

A few fragmentary turtle remains are available from the study area. At present, the painted turtle (Chrysemys picta) is the only turtle known from the drainage in Colorado or New Mexico. Use of turtle for ceremonial purposes makes assump-

tions based on a few fragments extremely dangerous.

• Sceloporus sp. Spiny Lizards.

This genus occurs today throughout the San Juan Basin of New Mexico and extends into the ponderosa pine forest area of Colorado.

• Sceloporus undulatus. Eastern Fence Lizard

This animal is an insensitive indicator, common throughout the study area. All recoveries were from rock shelters, usually as mummies.

• Ochotona princeps. Pika.

The pika is an animal occurring at and above timberline in the southern Rocky Mountains. As such, the remains (two femora, one tibia) from the archaeological sites must represent "carry-ins" by the Indians. It seems reasonably certain, then, that the Indians occasionally must have ventured above timberline. The distance traveled is difficult to estimate accurately, but, apparently, must have been no less than twenty-five miles. (The nearest published records place it considerably farther from LA 4380, but possible habitat occurs at about twenty-five airline miles).

The reason for bringing the animal such a great distance is not clear. If intended for food, there would seem to be a limited period during the year when such a trip would be feasible. The timberline habitat is extraordinarily severe in winter, which begins early and ends late, and during the warm months of the year it would be difficult to prevent meat from spoiling during the long journey. If of ceremonial import, it is likely that some other part than the skin was used. Otherwise, the carcass could easily have been discarded, rather than be carried such a distance. Perhaps the powerful force of human curiosity accounts for the presence of this animal so far from its native habitat.

• Sylvilagus auduboni and S. nuttali. Desert and Nuttall's Cottontails.

These two species of cottontail rabbits are treated together because the ecological range of the one complements that of the other. Nuttall's Cottontail is an upland dweller that reaches its lower limits in New Mexico in well developed pinyon-juniper woodland and in mesic, well vegetated valleys. The desert cottontail reaches its upper limits in pinyon-juniper woodland near the boundary between the woodland and the ponderosa pine forest. At present, some overlap occurs in the Reservoir area where preferred habitats interdigitate. In general, it is expectable that increased aridity would result in an increase of the Desert Cottontail over Nuttall's at any given geographic area and, further, that the converse would be true.

Use of X^2 tests shows no significant differences between the total samples of the different phases, with the exception of the Los Pinos-Sambrito Phase sample. This sample differs significantly in the case of S. nuttalli from Sambrito, Rosa, Piedra, Piedra-Arboles, and Arboles Phase samples: in the case of S. auduboni, the same sample differs significantly from the Sambrito Phase sample. These differences almost certainly are not the result of climatic phenomena. The samples from Los Pinos and Sambrito Phases show considerably smaller frequencies of the cottontails than does the transitional sample that supposedly overlaps both in time (Figs. 3,4). Moreover, the sample is demonstrably disturbed in that it contains Equus remains.

Although significant changes through time cannot be demonstrated for either of the animals singly, the ratio

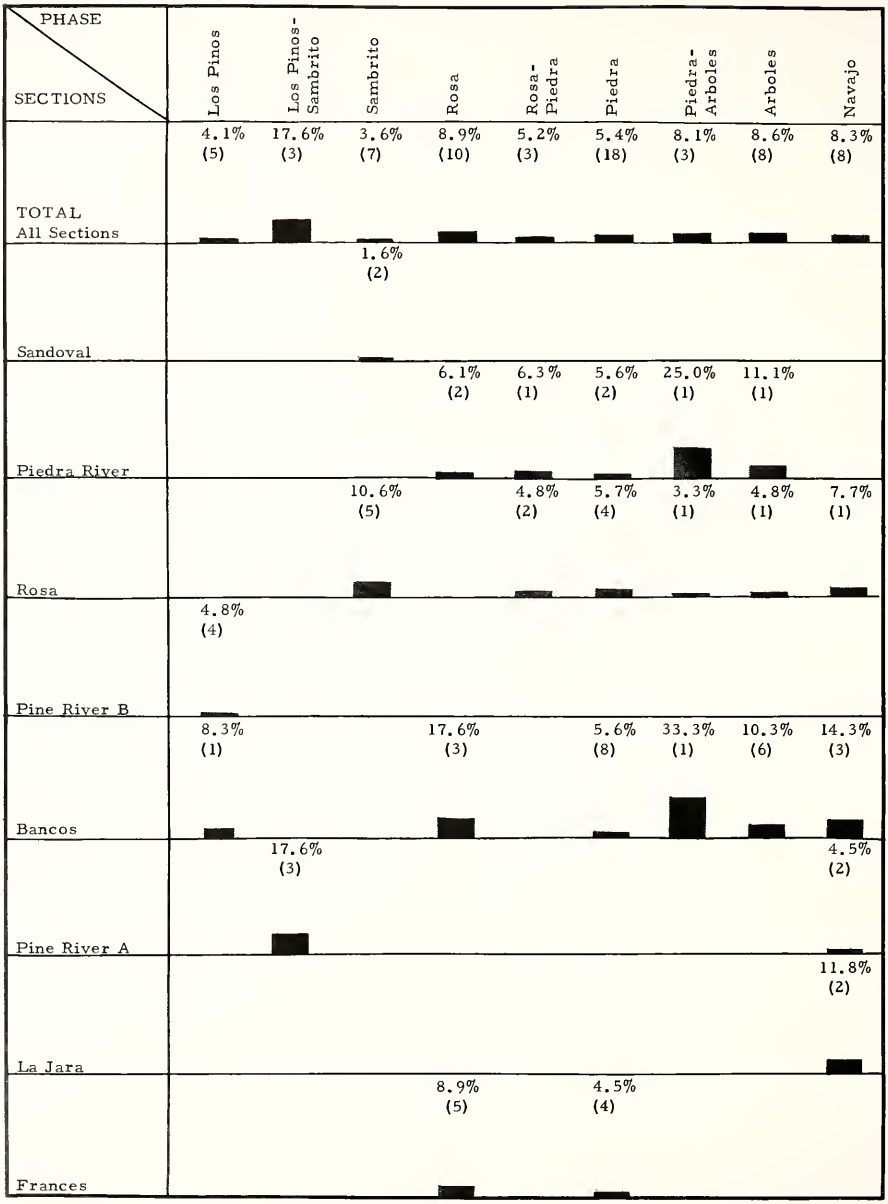


Fig. 3. Frequencies of Sylvilagus auduboni in each sample plotted by geographic section and cultural phases. Top row shows the totals for each cultural phase. %, per cent of total sample made up of S. auduboni; ( ), number of individuals of S. auduboni.

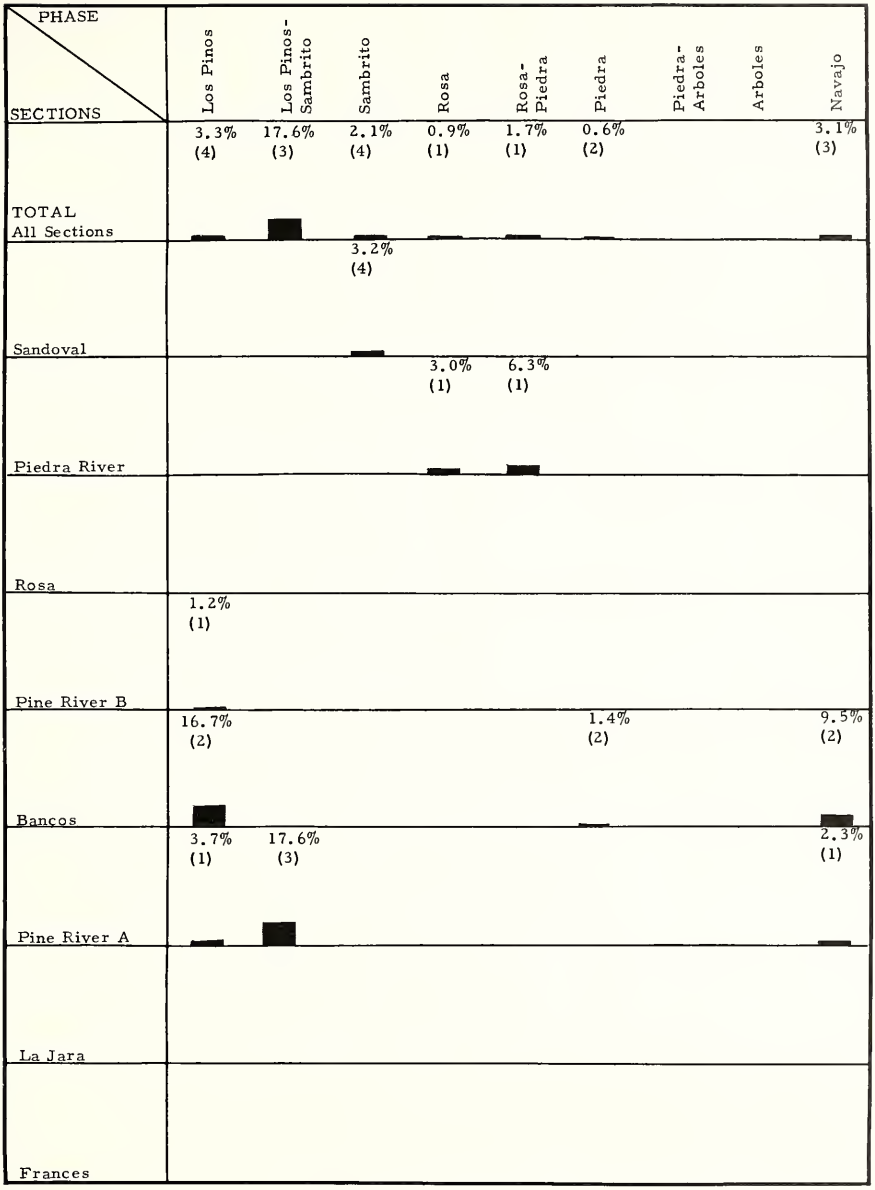


Fig. 4. Frequencies of Sylvilagus nuttalli plotted as in Figure 3.

of S. nuttalli to S. auduboni changes radically (Fig. 5) between Sambrito and Rosa Phase samples. Assuming climatic control, there seems to be recorded a reduction in S. nuttalli habitat together with an actual and relative increase in S. auduboni habitat.

Such habitat change might have been general, with well developed woodland giving way to sparser growth, and valley vegetation becoming more scanty. A portion of the change might be owing solely to loss of flood plain habitat through entrenchment, but it is doubtful that the entire change could be attributable entirely to that loss. At present, data on the relative importance of woodland and riparian growths for S. nuttalli are not available. The Navajo sample seems somewhat intermediate, but perhaps rather closer to pre-Rosa times.

• Lepus sp. Jack Rabbits.

The genus Lepus (exclusive of L. americanus) is sparsely represented in the Los Pinos and Sambrito Phase samples, but becomes common thereafter through the Arboles Phase (Fig. 6, Total A). A slight increase in frequency between Los Pinos and Sambrito Phase samples is not significant; the further increase during Rosa Phase is significantly higher when compared with the Los Pinos Phase, but not when compared with the Sambrito Phase sample. Thereafter, except for the relatively small sample from Rosa-Piedra Phase transition, samples from Los Pinos and Sambrito Phases differ significantly from all samples until the Navajo Period. The Navajo sample does not differ significantly from Los Pinos and Sambrito Phase samples, but it does differ from all other samples.

Thus, the frequency of jack rabbits in the samples increases from Los Pinos time, or from Los Pinos and Sambrito times, to a relatively high frequency during Rosa and succeeding phases through Arboles Phase. The rather intermediate position of Rosa Phase suggests that the most rapid increase in frequency was during this period.

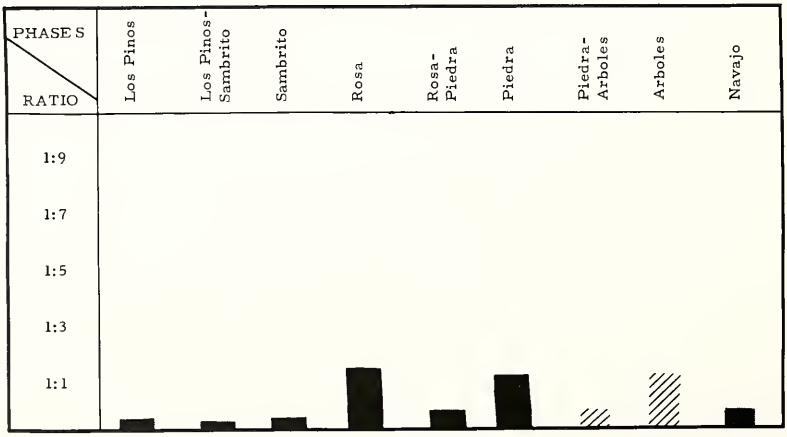


Fig. 5. Graph showing ratios of Sylvilagus nuttali to S. auduboni. Sylvilagus nuttalli is absent from Piedra-Arboles and Arboles Phase samples; plots are as if one S. nuttalli is present.

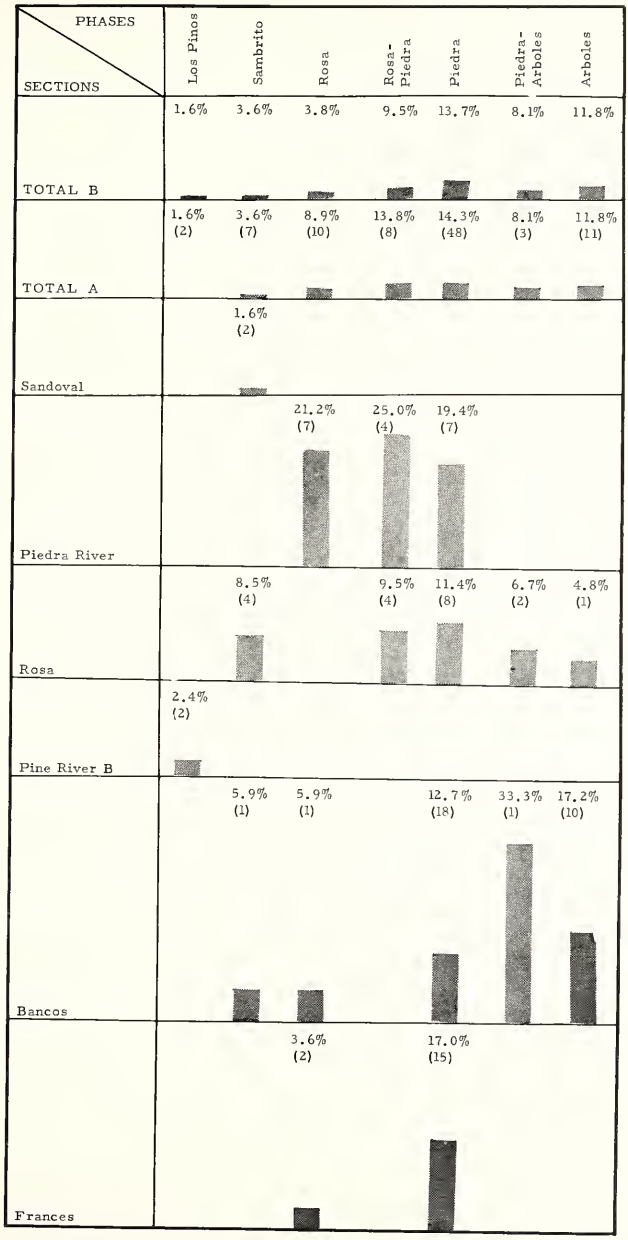


Fig. 6. Frequencies of Lepus sp. plotted as in Figure 3.

Changes in frequencies between geographic sections of the Reservoir seem reasonable, with the possible exception of the Piedra River Section. Here, in the most northerly position of the study area, there is found the greatest frequency. A possible explanation is the occurrence of two species of Lepus here, L. californicus and L. townsendi. The latter are not recorded from the Reservoir area, however. The trend of the samples remains somewhat similar with the removal of those from the Piedra River Section (Fig. 6), but the abrupt increase in frequency then occurs after Rosa times.

It is presumed that most or all specimens are of the species now occurring in the area, namely, L. californicus. In the San Juan Basin this animal is most common today in the shrub and shrub-grassland areas south of the San Juan River, but occurs as far north in the Reservoir area as the Sandoval Section (Harris, 1963). Within the Reservoir it is most common on sagebrush flats. The present ecological distribution suggests that a past expansion would very likely coincide with an increase in the amount of open, shrubby habitat in the Reservoir area. The time of such increase, as shown by the frequency of Lepus remains, would most likely have been during the Rosa Phase or near the close of the Rosa Phase; that is, about A.D. 700-900, or during the latter part of this time span.

- Cf. Lepus americanus.
  Snowshoe Rabbit.

This animal is almost undoubtedly a carry-in by Indians from a high altitude habitat.

- Eutamias cf. quadrivittatus.
  Colorado Chipmunk.

The rarity of this animal among the archaeological bone samples is surprising. The position of most sites may be a partial explanation, since it occurs today throughout the reservoir area along rocky exposures and in thick woodland and in forest; it is rare on the terraces, and rare or absent on the floodplain. It occurs, also, south and north of the area. Still farther north, it is replaced by the Least Chipmunk, E. minimus. This latter species would be expected in well developed ponderosa pine forest and in still higher altitude habitats.

- Marmota flaviventris.
  Yellow-bellied Marmot.

The temporal distribution of the marmot is not what would be expected when compared with other "sensitive" indicators. Within the samples from the Reservoir, the percentages of Marmota increase from 0.5% during Sambrito Phase to 6.5% during Arboles Phase (Fig. 7). Inasmuch as marmots apparently require green fodder for existence, such distribution should indicate either more precipitation or precipitation concentrated during the growing season. Evidence from the past distribution of other indicators is that the general trend from Sambrito to Arboles times was toward greater aridity.

That the observed differences probably are not attributable to chance alone can be demonstrated statistically only between Sambrito and Arboles times ($p =< 0.01$, 0.005). The Bancos Section sample seems particularly anomalous. This section, the most southerly to contain Marmot remains, shows higher percentages of the animal than do more northerly sections. The increasing percentage in each succeeding phase after Sambrito however, would seem to indicate a likelihood that the increase is real.

At present, there appears to be no logical explanation for this temporal distribution. It is perhaps most likely that one or more samples are biased in some manner. Alternative explanations, none apparently satisfactory, include: (1) possi-

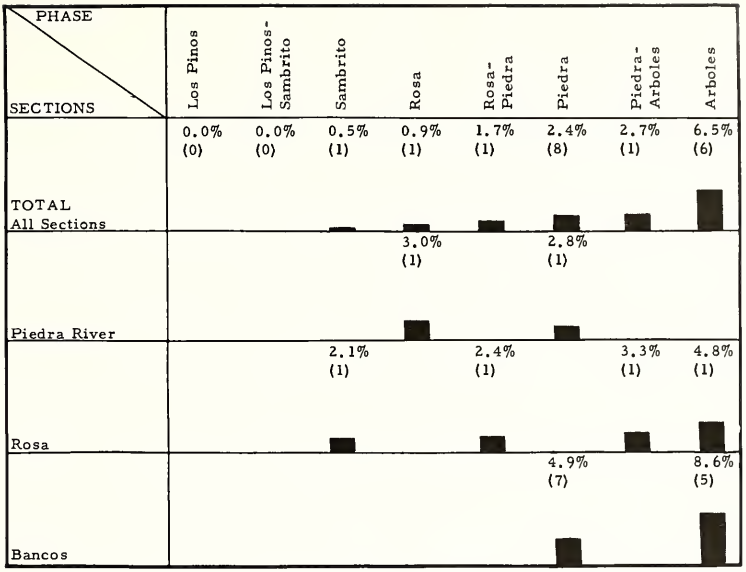


Fig. 7. Frequencies of Marmota flaviventris plotted as in Figure 3. No occurrences are recorded for the Frances, La Jara, Pine River, or Sandoval Sections.

ble increase in seep and spring activity, owing to recharging in earlier time, with formation of oases which were green throughout the warmer portions of the year; (2) increased frequency in spring (?) and summer flooding of the Recent Terrace, owing to faster runoff caused by depletion of the vegetal cover of the watershed; (3) replacement to greater or lesser degree of shrubby growth on protected, mesic canyon walls by grasses and forbs; and (4) an increase in suitable green fodder, owing to climatic change which is not revealed by other indicators.

Geographic distribution shows a past, southward extension of range some seven miles toward the Bancos Section. If absence of the marmot to the south of this section is real, this may be an indication that the precipitation regimen has not been such, in the period under consideration, to support green fodder throughout the warmer months of the year.

- Citellus leucrus.
White-tailed Antelope Squirrel.

This ground squirrel has been recovered only a short distance north of the nearest modern record. During the study of the modern fauna, it was hypothesized that this rodent might be found within the southern portions of the Reservoir in years of high population levels (Harris, 1963). Thus, this record may be a reflection of such a situation; otherwise, perhaps a somewhat more arid situation might have been present. The record is inconclusive in terms of environmental change.

- Citellus variegatus. Rock Squirrel

This common ground squirrel is an insensitive indicator of environmental change within the study area. It occurs today throughout the area and both to the north and south.

Most skeletal elements of this animal are extremely difficult to distinguish from those of Cynomys gunnisoni with any significant degree of certainty.

• Cynomys gunnisoni. Gunnison's Prairie Dog.

Gunnison's prairie dog is rather constant in frequency throughout the time span represented by the samples; significant differences between phases are not found. These data suggest that environmental changes were not of such magnitude as to allow great abundance, or to cause great depletion of the rodents.

Today prairie dogs are abundant in the grassland south of the San Juan River; in the Reservoir, colonies appear to be absent or very rare except in the vicinity of the Colorado state line. The degree to which this is a result of disturbance by man is unknown, but the favorite present-day town sites are in disturbed areas, usually near croplands.

It is quite likely that prairie dogs were used for food by the Indians, as has been the case in more modern times (Bailey, 1931, p. 128). If such a practice was common, the animals might well have been carried an appreciable distance.

• Sciurus aberti. Tassel-eared Squirrel.

The absence of greater numbers of this tree squirrel is more surprising than its presence. It lives almost entirely in association with ponderosa pine and Douglas fir, both of which are present today near the upper margins of the Reservoir.

• Tamiasciurus hudsonicus. Red Squirrel.

The red squirrel is quite strictly limited in the Southwest to spruce-fir forest. Evidence for the presence of such forest in the Reservoir area during the period under study is adverse, and the remains of this species are considered to have been brought in by the Indians from a higher elevation.

The red squirrel could have been used for food, for skins, or for both.

Thomomys sp. Pocket Gophers.

Pocket gophers are widespread in the Southwest. At present, one species (Thomomys bottae) occurs in the Reservoir area and to the south; a second species (T. talpoides) occurs at higher altitudes to the north. The ranges of the two,normally, are mutually exclusive. The distance above the Reservoir at which T. talpoides replaces T. bottae is unknown, but probably is not great.

All the specifically identifiable archaeological remains are of T. bottae.

Pocket gophers are burrowing animals that spend most of their lives underground. Bailey (1915, p.8) states that "The tunnels vary from about 6 inches to a foot below the surface,..." Extreme depths, however, are considerably deeper. Both species considered here live, primarily, on underground parts of herbs; however, above ground parts are used at times. At present, T. bottae is not plentiful in the Reservoir area but does occur on the floodplain; it is rare above the floodplains, except in irrigated cropland areas. Increased amounts of grasses and other herbs probably would allow utilization of much more of the upland habitat than is now possible.

The temporal and geographic distributions of Thomomys are plotted in Figure 8. Several problems arise in interpretation of the Thomomys distribution and in the general effect of Thomomys upon the samples. The possibility exists that in the case of a burrowing animal any stratigraphic

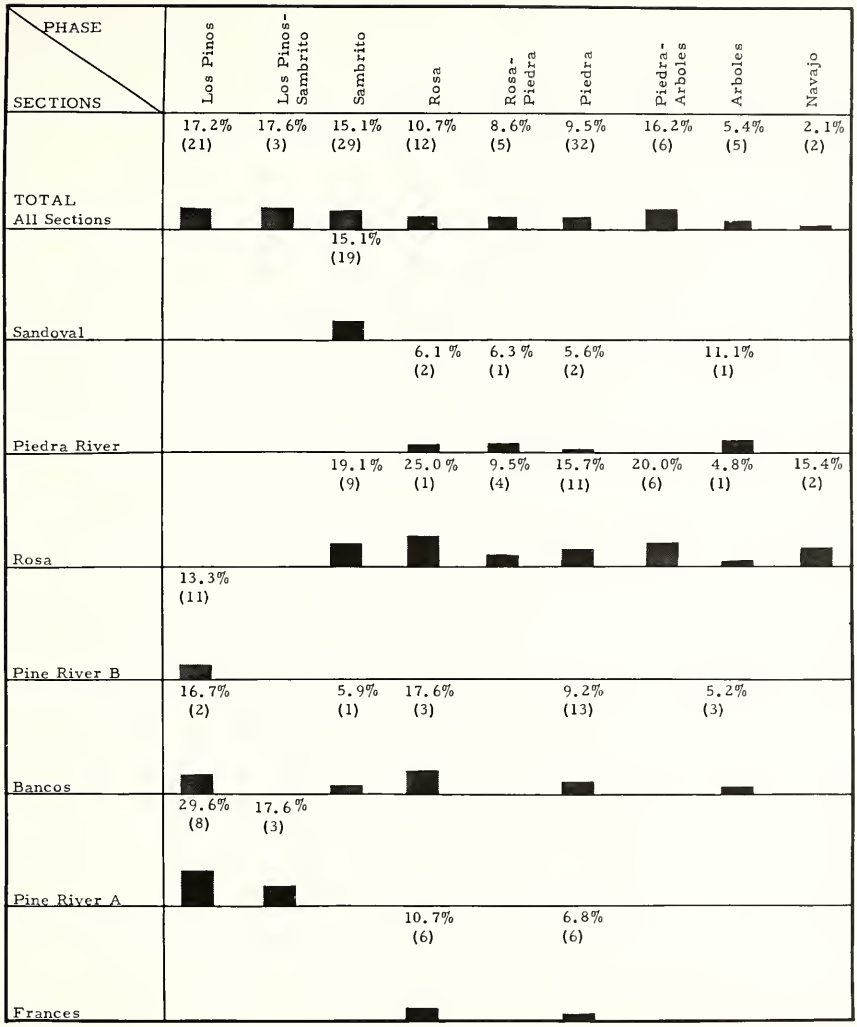


Fig. 8. Frequencies of Thomomys sp. plotted as in Figure 3. No occurrence is recorded for the La Jara Section.

level may continue to gain animals. Thus, even if such an animal maintained a constant proportion of the total fauna through time, recovered samples from older stratigraphic levels would contain appreciably larger percentages than samples from more recent levels.

If such accretion occurred, not only would there be an apparent, but artificial, decrease in numbers of gophers through time, but other members of older faunas would appear to be relatively less common than would be the case were the samples not so biased.

A decrease in proportion of gophers in the faunal samples is apparent. Samples from Los Pinos through Sambrito and Rosa through Arboles Phases differ significantly ($p =< 0.005$), as do Los Pinos-Piedra ($p =< 0.025$), Los Pinos-Arboles ($p =< 0.025$) Los Pinos-Navajo ($p = 0.005$), Sambrito-Arboles ($p =< 0.050$), and Sambrito-Navajo ($p =< 0.005$). However, such a decrease would be expectable if environmental conditions were such that grasses and herbs became scantier through time. Thus, the Thomomys trend is inconclusive.

If the trend is considered to be a result of accretion, then animals showing high percentages in the older deposits show even higher percentages in relation to more recent deposits when the fauna is considered without Thomomys. The differences are small enough so that the general picture remains the same under either alternative.

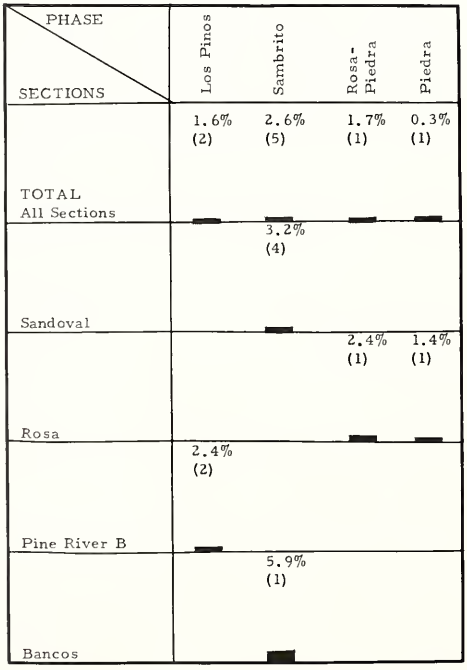


Fig. 9. Frequencies of Perognathus sp. plotted as in Figure 3. No occurrences are recorded in the Frances, La Jara, Pine River A, and Piedra River Sections.

- Perognathus sp. Pocket Mice.

Perognathus apache is represented in bone material from the study area; other remains are most likely of this species, but may be of P. flavus. All are here assumed to be of P. apache. The temporal and geographic distribution of the genus is shown in Figure 9.

The Apache pocket mouse occurs today throughout the Reservoir area, but, apparently, sparsely (Durrant and Dean, 1962, p. 169). The ecological niche of this animal cannot be equated with that of the Apache pocket mouse south of Navajo Dam and may even be a different species. Judging from the meager information available, it seems to require a somewhat mesic habitat compared to the southern form, but, in any event, probably a non-forest habitat.

Taken individually, samples from the various phases show no significant differences. However, when Los Pinos and Sambrito Phase samples are combined and compared with combined samples from Rosa through Arboles Phases, the sample differences are highly significant ($p =< 0.025$). The same is true when the Sambrito Phase sample is compared with the Rosa through Arboles combined sample ($p =< 0.010$). Other combinations tested (Los Pinos through Rosa--Rosa-Piedra through Arboles; and Los Pinos through Rosa-Piedra--Piedra through Arboles Phases) show no significant differences. Thus, a higher frequency of pocket mice occurs in the pre-Rosa samples than in the samples of the post-Sambrito Phases.

Assuming the presence of P. apache, only, a change toward greater aridity in

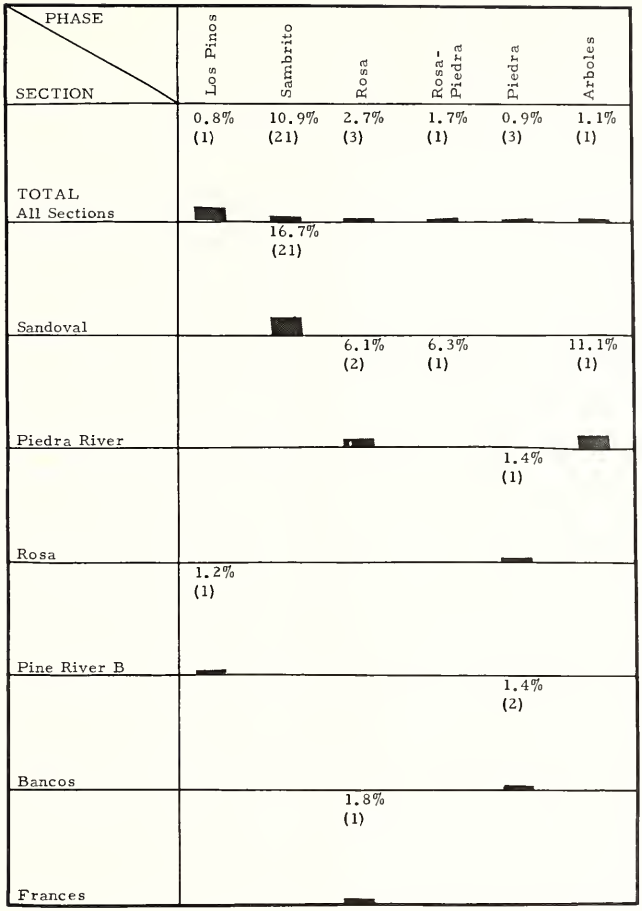


Fig. 10. Frequencies of Dipodomys ordi plotted as in Figure 3. No occurrences are recorded in the La Jara and Pine River A Sections.

post-Sambrito times is indicated. If all are not P. apache, then no definite pattern emerges.

- Dipodomys ordi. Ord's Kangaroo Rat.

The appearance of Dipodomys ordi remains from the northern portions of the Reservoir area (Fig. 10) was a distinct surprise. The nearest known occurrence to the Reservoir today is at two miles north west of Blanco (Harris, 1963). Originally, it was thought likely that edaphic conditions were unsuitable for this animal and, accordingly, prevented its entrance into the area. However, if this were the case, we would have to postulate either a change in the substratum or transport by the Indians.

Fig. 11. Dipodomys ordi habitat on continental divide, ca. 10 mi. west and 9½ mi. south of Hospah, McKinley Co. Snakeweed, rabbitbush, and grasses are prominent members of the vegetation; sparse to very dense pinyon-juniper growth surrounds these more open areas. Some sand occurs in the area. View is to the west.

Soil conditions more suitable to kangaroo rats presumably would consist of a sandier substratum, at least locally. Evidences of past increase in such conditions in the form of old dunes or sandy strata within pit house fill appear to be absent.

Transport by Indians is unlikely. The distances involved are such that it would seem impractical to carry animals of such small food value to the villages. Presence of at least one near-complete skeleton also points to non-utilization as food. Its wide spread of occurrence, both temporally and geographically, within the reservoir should also be noted.

At present, the most plausible explanation of the presence of this creature in the Reservoir area would seem to be that the factor now limiting is geographic range is to be found in the present vegetation. Grasses and many forbs are rare today compared with those present in areas to the south, where D. ordi does occur. Conditions suitable for pinyon-juniper growth are not, in themselves, sufficiently adverse to prevent the presence of the rat. I have taken these animals in areas almost on the continental divide, in large open places within well-developed woodland areas (Fig. 11). Thus, the presence of much better developed grass and/or forb growth than is now present, associated with pinyon-juniper woodland, could account for this past distribution.

Introduction of domestic stock conceivably could have changed the habitat to such a degree as to exclude Ord's kangaroo rat from the area. At best, it seems likely, in view of the less than ideal substratum, and of the probably presence of woodland growth, that the area would have been marginal for kangaroo rats at any time in the period under consideration. Thus, grazing, quite conceivably, could have extirpated the genus from the area. It is also possible that the presumed drought conditions of the 1200's or 1500's (Schulman, 1956, p. 69), could have encouraged the growth of shrubs, particularly big sagebrush, at the expense of more palatable plants and have banished D. ordi from this region.

Statistical analysis shows that the Sambrito Phase sample differs so widely from the other samples that it is unlikely to differ merely by chance (in the null hypothesis, $p =< 0.005$ when the Los Pinos and Sambrito samples are compared, and $p =< 0.05$ for the Sambrito and Rosa samples).

In the case of other "sensitive" indicators used in this paper, agreement in percentages between the Los Pinos and Sambrito Phase samples is good. (However, an exception is found in the Los Pinos-Sambrito transition sample, for Sylvilagus auduboni and S. nuttalli.) Thus, the assumption that the high percentage of kangaroo rat remains in the Sambrito sample is owing to climatic control seems quite unlikely. More probably, an exceptionally favorable site for construction of burrows was uncovered during excavation. An alternative possibility lies in collecting bias.

Suppose we accept the proposition that the Sambrito Phase sample is not the result of climatic control and that an unbiased sample would show approximately the same percentage of kangaroo rats as does the Los Pinos Phase sample. Then there is no demonstrable trend of decreasing abundance of the animal through time (in the best post-Sambrito example, between Rosa and Piedra times, $p = > 0.10$). The supply of small animal remains during the Navajo Period is so meager as to preclude determination as to whether or not the animal was present during that period. Thus, the animal may have occurred within the Reservoir until settlement by the white man in the late 1800's, or it may have died off at an earlier, post-Arboles Phase time.

- Castor canadensis. Beaver.

The beaver tells us little of past environments except in regard to the presence of permanent streams. If dams are built, sufficient water for protection must remain behind the dams throughout the year; if burrows are used, entrance to them must be covered by water. Further, sufficient vegetation for food must grow near the streams.

Both pelt and flesh of the beaver are valuable and could be carried for considerable distances by the Indians.

- Reithrodontomys sp. Harvest Mice.

Only one species, R. megalotis, is known from the San Juan basin today and the remains from the study area probably represent this species.

Both the geographic and ecological distributions of this small rodent are so broad as to give little information on past environments. Although some grasses usually are present where it occurs, the individual plants may be quite sparsely spaced.

- Peromyscus sp. White-foot Mice.

This genus is represented by four species within the Reservoir area today: P. truei, P. boylii, P. maniculatus, and P. crinitus. Comparative osteological studies are needed before separation of these species can be accomplished with much certainty on the basis of most skeletal elements.

All four species differ in ecological tolerances and in geographic distribution, though considerable overlap occurs in both categories. The only species definitely identified (P. maniculatus), has the widest range of any of the species in the study area and is considered a nonsensitive indicator.

- Onychomys leucogaster. Northern Grasshopper Mouse.

This rodent is present today within the study area, but appears to be rare.

Fig. 12. Onychomys leucogaster habitat, Cañad... Largo, $1\frac{1}{2}$ mi. north and 5 mi. west of Lindrith, Rio Arriba Co. The larger shrubs are big sagebrush. Note the grass and other low plants among the sagebrush. Pinyon-juniper woodland is quite well developed outside the canyon. View is approximately west.

The few specimens taken were from sagebrush areas (Durrant, 1961, p. 173). To the south, the animal is not uncommon in grassland areas and in arid shrublands. It has been taken in areas surrounded by well-developed woodland in the San Juan Basin, but in association with diversified low growth along washes (Fig. 12). Much denser, non-sagebrush, low cover might well exhibit increased numbers of Onychomys leucogaster.

The mouse occurs in greatest frequency in Los Pinos and Sambrito Phases; it is rare after Sambrito Phase, being represented only by one individual (Fig. 13). The Los Pinos and Sambrito Phases cannot be shown to differ significantly, nor can the Los Pinos and Piedra Phase samples. The Sambrito and Piedra Phase samples show highly significant differences ($p = <0.005$). Thus, a major change appears to occur between Sambrito and post-Sambrito Phase samples.

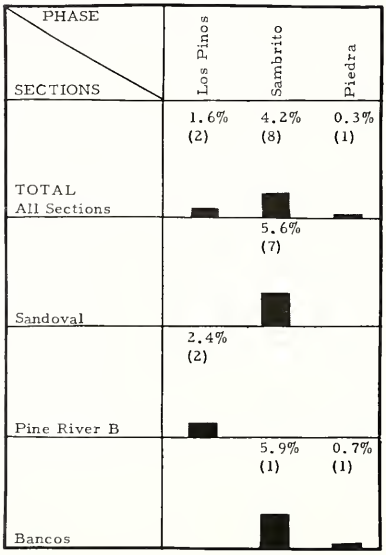


Fig. 13. Frequencies of Onychomys leucogaster plotted as in Figure 3. No occurrences are recorded in the Frances, La Jara, Pine River A, Rosa, and Piedra River Sections.

- Neotoma sp. Wood Rats.

Three species (N. albigula, N. mexicana, and N. stephensi) occur today in the study area. A fourth species (N. cinerea) occurs to the north (N. c. orolestes) and to the south (N. c. arizonae). The three species present today overlap in distributions to such a degree that quantitative data would be required to obtain meaningful results.

The absence today of N. cinerea in the Reservoir area is difficult to explain, since elsewhere the two subspecies apparently intergrade (Finley, 1958). Judging on the basis of the most typical habitats of the subspecies, presence of N. c. orolestes in the Reservoir area would indicate more mesic conditions, whereas that of N. c. arizonae would indicate somewhat more arid conditions.

Our comparative skeletal material of these subspecies is too limited to definitely state which subspecies is represented in the archaeological remains. Comparative material of N. c. orolestes more nearly matches in size the archaeological specimen than does that of N. c. arizonae; however, Finley, (1958, p. 262) implies that there is some overlap in size between the subspecies.

- Microtus sp. Voles.

Identification of Microtus, to the generic level only, is of relatively little aid here in the reconstruction of the past environment, except as an indication of some type of rather mesic habitat occurring in the area.

• Microtus pennsylvanicus.
Meadow Vole.

In the San Juan drainage, the meadow vole is found principally in sedgebed areas from the vicinity of Blanco west to that of Fruitland, New Mexico. The occurrence of this animal in the archaeological bone material probably indicates the presence of similar habitat.

Marshy areas, in the Junction Land Form, are most likely to have occurred on the floodplain. If channeling of the floodplain had occurred, such areas would probably be few and disconnected, supporting only isolated populations. If such populations occurred, apparently they have been extirpated. If, as was likely, M. pennsylvanicus continued north of Blanco up the San Juan into Colorado before channeling of the floodplain, it is probable that the northern populations were wiped out after isolation from the southern owing to loss of habitat or to unsuccessful competition with M. montanus.

• Microtus longicaudus.
Long-tailed Vole.

The long-tailed vole is relatively common in Los Pinos and Sambrito Phase samples, but becomes rare thereafter (Fig. 14). The Los Pinos sample differs significantly from the Piedra sample ($p = <0.005$), but not from the Sambrito sample. The latter does not differ significantly from the Piedra sample.

At present, two kinds of voles occur in the Reservoir area: the montane vole (Microtus montanus) and the long-tailed vole. The latter is known to enter the Reservoir area only marginally in the Sandoval Section, becoming more common in the ponderosa pine-Douglas fir forests to the north. There it occupies the generally more open forest floor, utllizing logs, burrows, and patches of vegetation for cover. The northern part of the Reservoir

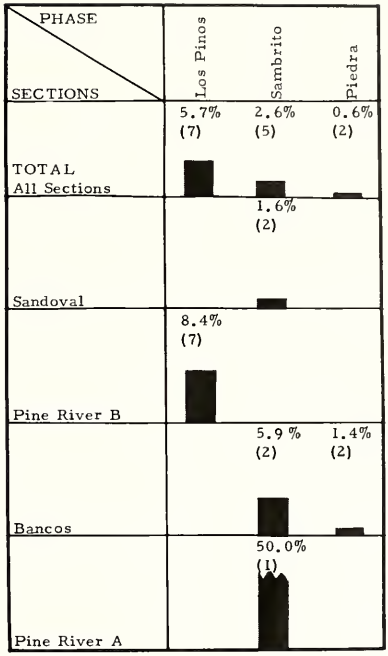


Fig. 14. Frequencies of Microtus longicaudus plotted as in Figure 3. No occurrences are recorded in the Frances, La Jara, Rosa, and Piedra River Sections.

area, as far south as a locality near the mouth of Sambrito Creek, is inhabited by the montane vole. This vole is generally limited to much denser cover than is the long-tailed vole.

South of the range of M. longicaudus, most areas possess essentially two types of habitat in terms of cover. Mesic streamsides and irrigated areas are covered with dense growth of grasses and sedges; willows often form dense stands. Outside these mesic areas, cover is scanty. It was hypothesized previously (Harris, 1963) that M. longicaudus is absent from the southern areas because the non-mesic areas possess cover too scanty for occupation, while the

streamsides and irrigated areas are occupied by the montane vole, which excluded the long-tailed vole.

The montane vole has not been identified from the prehistoric bone material. On the basis of the above hypothesis, it should have occurred on floodplains and other mesic areas. Most archaeological sites in the Reservoir area are situated above such habitat. Thus, the montane vole would not be expected, commonly, to be found in most sites unless carried in. Conditions in the vicinity of the sites, however, must have been such that the long-tailed vole could exist. This implies a greater amount of cover than is present in such situations today. Such cover would not need to be continuous, but may well have occurred along minor drainageways, on northerly slopes, etc. Isolated areas of such cover would, in favorable locations, persist after most of the cover had disappeared under more arid conditions. This is a possible explanation for the presence of the vole during the Piedra Phase. On the other hand, the presence of this vole during Piedra times may indicate improved cover conditions over the preceding Rosa Phase.

• Ondatra zibethicus. Muskrat.

Muskrats, living primarily on aquatic vegetation and utilizing water for protection from predators, indicate permanent water of sufficient slackness to allow growth of considerable amounts of aquatic plants. At present, muskrats are unknown in the reach between the irrigated lands near the State line and the marshy areas south of Navajo Dam.

Presence of muskrats at the sites, if the animals have not been carried in, may indicate that degradation of the river channel had not yet occurred, thus allowing permanent bodies of water to form on the floodplain, or that the stream waters were pooled and floods were not so violent as to destroy areas of aquatic vegetation.

• Erethizon dorsatum. Porcupine

In the absence of sufficient quantitative data, the porcupine is not a reliable indicator of ecological conditions. While it is most commonly found in wooded areas, it occasionally wanders far from such habitats. I have seen it, for example, in creosote bush desert in the Tularosa Basin of southern New Mexico. The animal is not so common in the bone samples as to be useful for consideration here.

• Canis sp. Dogs.

Dog remains from the Reservoir area probably include wolf (Canis lupus), coyote (C. latrans), and domestic dog (C. familiaris). The difficulty of identifying the various species of Canis from the skeletal elements, coupled with the virtual inutility of Canis as an indicator of environmental conditions, has resulted in little time being spent with this genus. At least two varieties of C. familiaris appear present; and animals identified as C. lupus and C. latrans may, in actuality be other forms of domestic dog.

• Vulpes sp. Foxes.

The record of Vulpes cf. macrotis and of ? Vulpes is not considered surprising or particularly informative. Vulpes fulva occurs now in the general Reservoir area and V. macrotis in the grassland areas to the south. Both might have been present naturally in the area on occasion or have been carried in.

• Urocyon cinereoargenteus. Gray Fox.

The gray fox is quite common in the Reservoir area today and in other pinyon-juniper areas in this portion of the Southwest. Its rarity in the sites is some-

what surprising but fails to shed much light on environmental changes.

• Ursus cf. americanus. Black Bear.

Bears generally range widely as individuals and are not sensitive indicators of environment.

• Bassariscus astutus. Ringtail.

This animal, like so many of the carnivores, is an insensitive indicator in this region.

• Martes americanus. Marten.

The marten usually is an animal of a considerably higher life-zone than is represented in the study area at present. Judging on the basis of the faunas revealed by the archaeological work, the marten was not a native member of any of these faunas. The specimen probably represents an individual carried in by the Indians.

• Mustela frenata.
Long-tailed Weasel.

This animal is another insensitive indicator of environmental conditions. It is widespread in those valleys of New Mexico that carry permanent water.

• Taxidea taxus. Badger.

The wide ecological tolerances of this animal indicate its inutility for our purposes.

• Felis concolor. Mountain Lion.

The mountain lion occurs in most habitats of the Southwest and is an extremely insensitive indicator of environmental conditions.

• Lynx cf. rufus. Bobcat.

Like most of the larger carnivores, the presence of bobcat indicates virtually nothing about environmental conditions.

• Equus cf. caballus. Horse.

Horse remains in pre-Navajo samples undoubtedly are intrusive, and thus are indicative of disturbance of the deposits.

• Tayassu sp. Peccary.

The canine tooth from the bone samples very probably represents a trade item. The tooth differs somewhat, particularly in size, from our specimens of the collared peccary, T. tajacu, and may be derived from the white-lipped peccary, T. pecari. The latter species now occurs north to northern Mexico; the former to north-central Arizona, southwestern New Mexico, and southeastern New Mexico.

• Cervus canadensis. Wapiti.

The wapiti, or American elk, suffers much the same disadvantages as an environmental indicator as the mule deer. The wapiti occurs occasionally near or in the northern parts of the Reservoir area today, and in the past it undoubtedly ranged farther south.

• Odocoileus hemionus. Mule Deer.

Relatively few of the remains could be identified definitely to this species, but,

since no other kind of deer is expectable in this area during the time span with which we are dealing, all deer remains are assigned to this species.

The mule deer is a doubly insensitive indicator of environmental conditions because it is extremely widespread in distribution, both ecological and geographic, and has long been a favorite source of meat for man. Its size is such that it is worth traveling a considerable distance to obtain. It has also supplied tool material to man.

- Antilocapra americana. Pronghorn.

Although individuals may wander over a considerable geographic range, generally they are animals of rather open country. One individual has been seen in the Reservoir area.

Absent in the Los Pinos and Sambrito Phase samples, the presence of pronghorn in Rosa through Navajo samples may indicate a response to a more open habitat. Their desirability as a food animal, however, makes dangerous such an assumption.

- Ovis canadensis. Mountain Sheep.

The widespread geographic range of the mountain sheep, or bighorn, before the advent of the white man, and the desirability of this animal for food place it in the category of the insensitive indicators.

The increase in frequency in post-Sambrito samples may well indicate a change in hunting emphasis by the Indians.

DISCUSSION AND CONCLUSIONS

Of the identified vertebrate fauna, over half of all the kinds appear to give no useful information on past environmental changes (Fig. 15). Some simply are not sensitive indicators within the range of environmental conditions with which we are dealing here. Peromyscus maniculatus is an example. Others of this group might provide considerable information if certain types of changes had occurred or if sufficent numbers could be identified to a lower taxonomic level. For example, the presence of P. crinitus in considerable numbers among the now unspecifically identified Peromyscus could indicate more arid conditions.

The remainder of the fauna consists of animals not now present in the Reservoir area (Fig. 16),or of animals showing changes in distribution or frequency, or both,through time (Fig. 17). Interpretation of past environmental changes must rely predominantly on these animals.

The members of the fauna given in Figure 16 might be expected to reveal environmental changes most dramatically. However, care must be taken in using them. Some of these animals (Martes, Tamiasciurus, Ochotona, and cf. Lepus americanus) are rather strictly limited to spruce-fir forest, or to a yet higher life-zone. An interpretation based solely on these elements would require a shift in climatic conditions similar to those occurring during the Pleistocene. When the fauna associated with these mammals is considered, it is seen that the major portion of the fauna represents neither these life-zones nor conditions approaching such. Thus, such creatures as Ochotona almost surely represent trade items or carry-ins by the Indians.

The information gained from the elements just mentioned is of interest primarily to the archaeologist as showing possible trade routes and wanderings by the Indians. Some of the elements of higher life-zones almost certainly represent excursions by the inhabitants of the Reservoir area into high altitude environments twenty-five or more miles distant. The javelina canine, more than likely, is a trade item, probably originating at the nearest in central Arizona, or even representing trade lines beginning in southern

---

Fig. 15. List of identified animals not found useful in this study. See text for discussion.

Bufo woodhousei	Reithrodontomys megalotis	Canis familiaris	Equus cf. caballus
Rana pipiens	Peromyscus maniculatus	Vulpes cf. macrotis	Cervus canadensis
Chelonia	Peromyscus sp.	? Vulpes	Odocoileus hemionus
Spiny Lizard	Neotoma sp.	Cf. Urocyon	Antilocapra americana
Sceloporus undulatus	Neotoma albigula	Ursus cf. americanus	Ovis canadensis
Eutamias cf. quadrivittatus	Neotoma stephensi	Mustela frenata	Ovis aries
Citellus variegatus	Neotoma cinerea or mexicana	Taxidea taxus	Anuran
Cynomys gunnisoni	Ondatra zibethicus	Felis concolor	Bos or Bison
Castor canadensis	Canis latrans	Lynx cf. rufus	

Mexico or farther south. Animals considered to be trade items or carry-ins are listed in Column A of Figure 16.

Other elements shown in Figure 16 (Column B) could quite possibly occur naturally within the area with the occurrence of more reasonable shifts in environmental conditions. For example, Citellus leucurus occurs at present up to the vicinity of Navajo Dam and may extend slightly farther north. Little shift would be required to bring this ground squirrel to the area where it was recovered.

Not only the present geographic distribution, but also the ecological requirements of the animal must be considered. Thus, although Microtus pennsylvanicus today occurs a number of miles from the Reservoir area, its habitat could logically have been present in that area. This is not the case for such animals as Ochotona.

Other factors are taken into account in judging which of the animals listed in Figure 16 should fall into Column B. Bighorn sheep (which, incidentally, might fit as well into Figure 15 as into Figure 16) represents an animal well worth the effort of hunting and carrying a considerable distance. A mouse, on the other hand, is neither worth going miles to hunt, nor, if caught, carrying an appreciable distance to the village. A large animal can and often does move considerable distances naturally; most smaller rodents are much more restricted in their range.

Distribution of the animals within the samples also has a bearing upon the likelihood of their being natural elements of the fauna. An animal restricted to one site and level is far more suspect than one more generally distributed among various sites and stratigraphic levels.

The animals shown in Figure 17 are helpful in much the same way as those of the B Column in Figure 16. A real change in frequency within a fauna, or a real change in geographic distribution must have a reason. The reasons may be various and may be impossible to discover at this late date. General climatic or major floristic changes, however, should affect a number of animals, not necessarily in the same way, but in a manner revealing the type of change, if the ecological requirements of the animals are known.

A number of species represented in the archaeological samples do, indeed, show changes expectable under conditions of general climatic and floristic change. As inspection of the individual accounts shows (see also Figure 18), major changes in frequencies and/or distributions (Figs. 19-24) which occurred during late Sambrito or early Rosa Phase times, with changes of lesser magnitude probably continuing after early Rosa time.

Several species are abundant in Los Pinos and Sambrito times relative to their frequencies in post-Sambrito samples. Microtus longicaudus, apparently, requires

Fig. 16. Lists of animals identified from the Navajo Reservoir District which do not occur there at present. Column A, animals considered to be trade items or carry-ins; Column B, animals considered to have occurred in the District naturally.

A	B
Ochotona princeps	Citellus leucurus
cf. Lepus americanus	Sciurus aberti
Tamiasciurus hudsonicus	Dipodomys ordi
Martes americanus	Neotoma cinerea
Tayassu sp.	Microtus pennsylvanicus

Fig. 17. List of animals which are useful as environmental indicators and now occur in some portion of the Navajo Reservoir District. Changes in geographical distribution and/or frequencies supply information on past environment.

Sylvilagus auduboni
Sylvilagus nuttalli
Lepus sp.
Marmota flaviventris
Thomomys sp. and T. bottae
Perognathus sp. and P. apache
Onychomys leucogaster
Microtus longicaudus

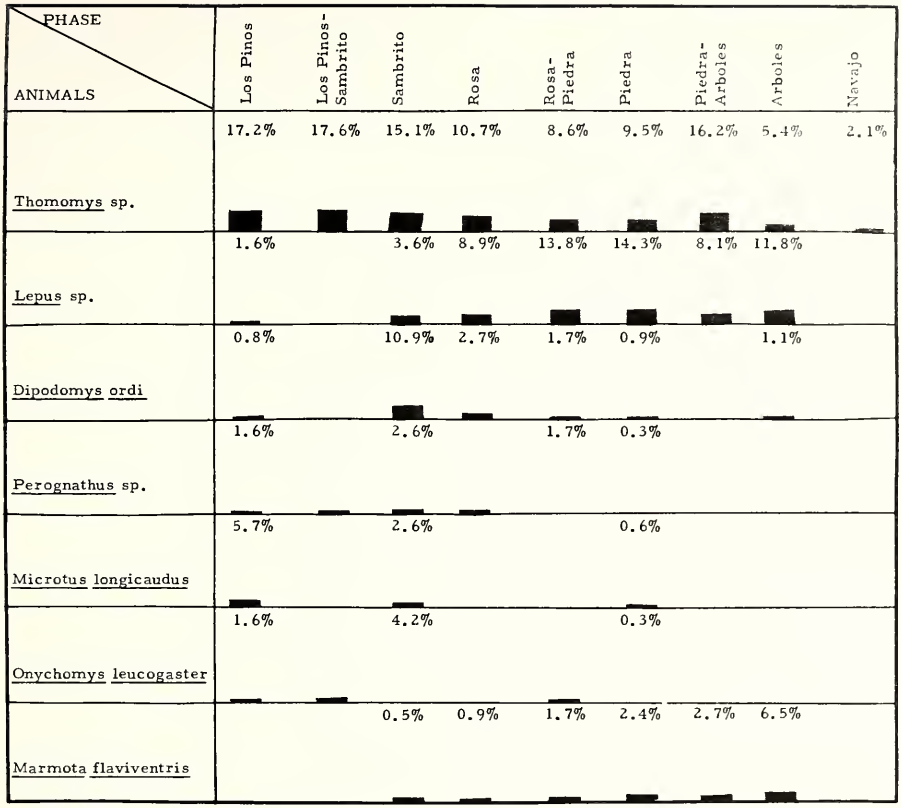


Fig. 18. Graph showing distribution in per cent of several sensitive indicators by cultural phase.

more cover than is supplied throughout most of the non-riparian parts of the Reservoir area today. The riparian areas where inhabited by Microtus, support a different species, M. montanus. Onychomys leucogaster occurs today only rarely in the scant cover of sagebrush, but has been taken elsewhere abundantly in areas of fair grass and low shrub cover in or near pinyon-juniper growth. Perognathus, of the species with which we are most probably dealing here, appears restricted to pinyon-juniper woodland is rare today. Fluctuations of population numbers in the past presumably would depend upon some factor in this woodland habitat. For example, increased aridity would favor the lower life-zone pocket mice (P. a. apache and P. flavus), and thus it appears probable that slightly more mesic conditions would favor this animal. The requirements of Thomomys are such that the presence of ample low cover would favor expansion of range and numbers. Sylvilagus nuttalli apparently inhabits situations where cover is relatively dense. Such cover occurs in two forms in the study area: (1) dense pinyon-juniper woodland, and (2) dense riparian growth. The presence of this animal implies the presence of one or both of such habitats.

One species (Lepus californicus) was considerably less abundant in pre-

Rosa times. This species is present within all but the northernmost portions of the Reservoir area today (most Lepus remains undoubtedly are of this species). Its favored habitat in the Reservoir area is in the big sagebrush growth, but it occurs also in open pinyon-juniper woodland and may enter the lower areas of ponderosa pine forest. South of the Reservoir area it appears to be most common in the rather barren shrubby growth and is more rare in grassland areas. Thus, its lower frequency in the pre-Rosa samples may indicate less in the nature of barren sagebrush and more in the way of a varied low cover. Another possibility, however, occurs in the switch (presumably at about the end of Sambrito Phase) from use of the atlatl as a primary weapon of the hunt, to the bow. The increased range and accuracy of the bow and arrow may have resulted in the jack rabbit becoming a more common item of post-Sambrito diets.

Ord's kangaroo rat, now absent from the Reservoir area, remained quite constant in frequency throughout Pueblo times (with the exception of the Sambrito sample, which is believed to be greatly biased.) Its presence in the Reservoir area until the end of the Pueblo Period record is believed to indicate a greater amount of low cover throughout that period than is present today. This does not rule out changes in plant cover within the tolerances of this species.

Many of the same animals indicate the environmental limits in the opposite direction. Sylvilagus auduboni, O. leucogaster, Perognathus sp., L. californicus, and D. ordi seldom occur in even dense woodland growth, let alone forest of higher life-zones.

With these limits in mind, it appears likely that during Los Pinos and Sambrito Phases, the Reservoir area was characterized generally by greater or lesser amounts of pinyon-juniper woodland and many open spaces. The understory growth of the woodland consisted in part of grasses and other herbaceous plants in fair density; the open areas probably also were covered with forbs, grasses, and low shrubs. Big sagebrush probably did not dominate large areas, as it does today. Ponderosa pine and Douglas fir probably occurred in protected areas throughout the study area in considerably greater numbers than at present. However, then as now, they occurred in isolated stands rather than as a true forest.

The trend toward greater aridity probably began in late Sambrito or early Rosa times. From about A.D. 700 to 800 very little bone material is available (seven individuals are represented). With the approach of A.D. 800 a very considerable change had taken place: Sylvilagus auduboni was far commoner than S. nuttalli; O. leucogaster, M. longicaudus, and Perognathus sp. do not appear in the samples (their absence, however, could well be fortuitous); the D. ordi frequency is somewhat larger (again, quite possibly the result of chance); and the Lepus frequency is more or less intermediate between Sambrito and Piedra Phase samples. It seems likely that during the above period the study area was hit by drought that was so severe as almost to extirpate certain animals dependent upon low cover, yet not so strong as to remove D. ordi. Disregarding the probably biased Sambrito sample for D. ordi, the slight increase during Rosa times might indicate that the pre-Rosa environment was not so near optimum for this animal as the Rosa Phase environment. In other words, at some point during Rosa times the increasing aridity resulted in cover or food resources that more closely approached the ideal than previously. It should be recognized, however, that all changes in frequency of D. ordi could be owing to chance, alone, except that change in frequency which is displayed during Sambrito time. The Rosa sample shows a somewhat intermediate frequency for Lepus (significantly different from Los Pinos, but not reaching the five per cent level of significance in the case of Sambrito or Piedra samples), possibly indicating

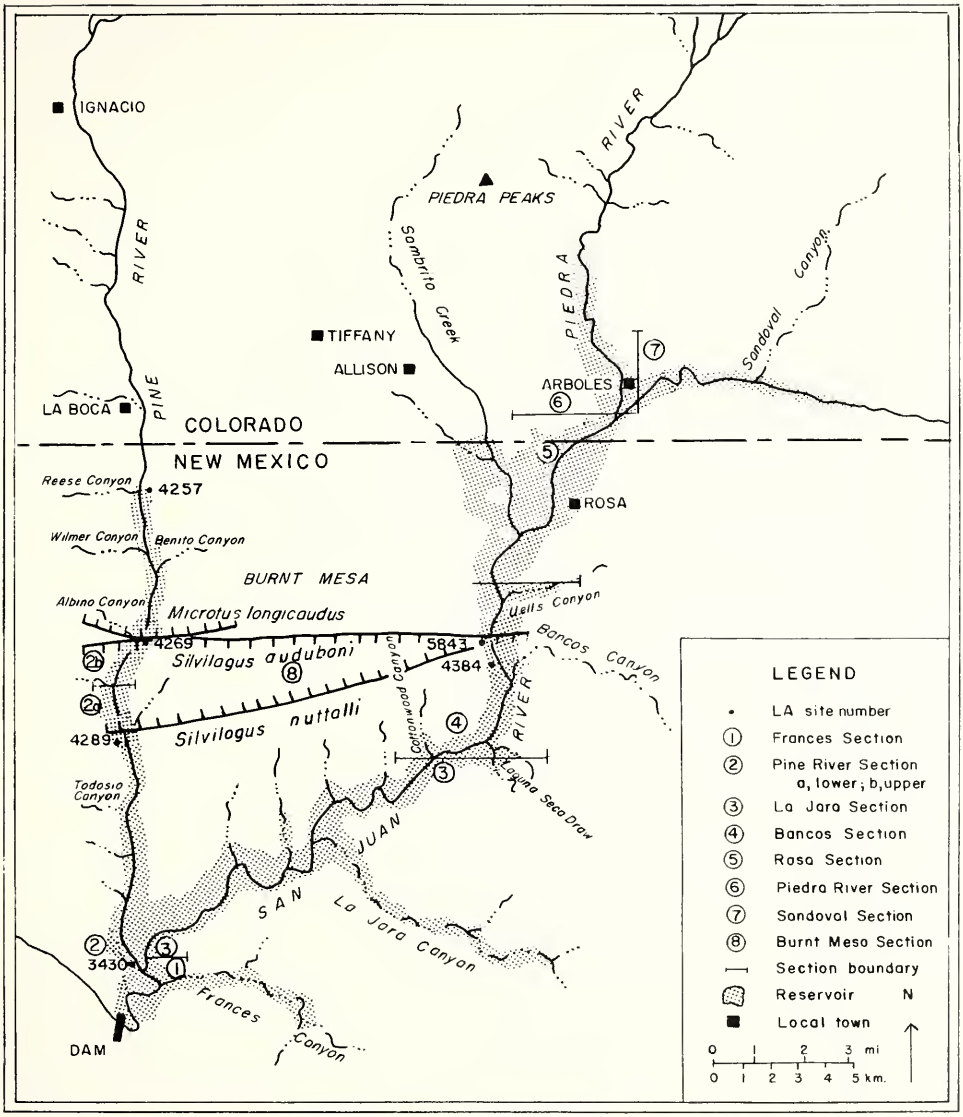


Fig. 19. Minimal southern limits of distribution of M. longicaudus and S. nuttalli and northern limit of distribution of S. auduboni during Los Pinos Phase.

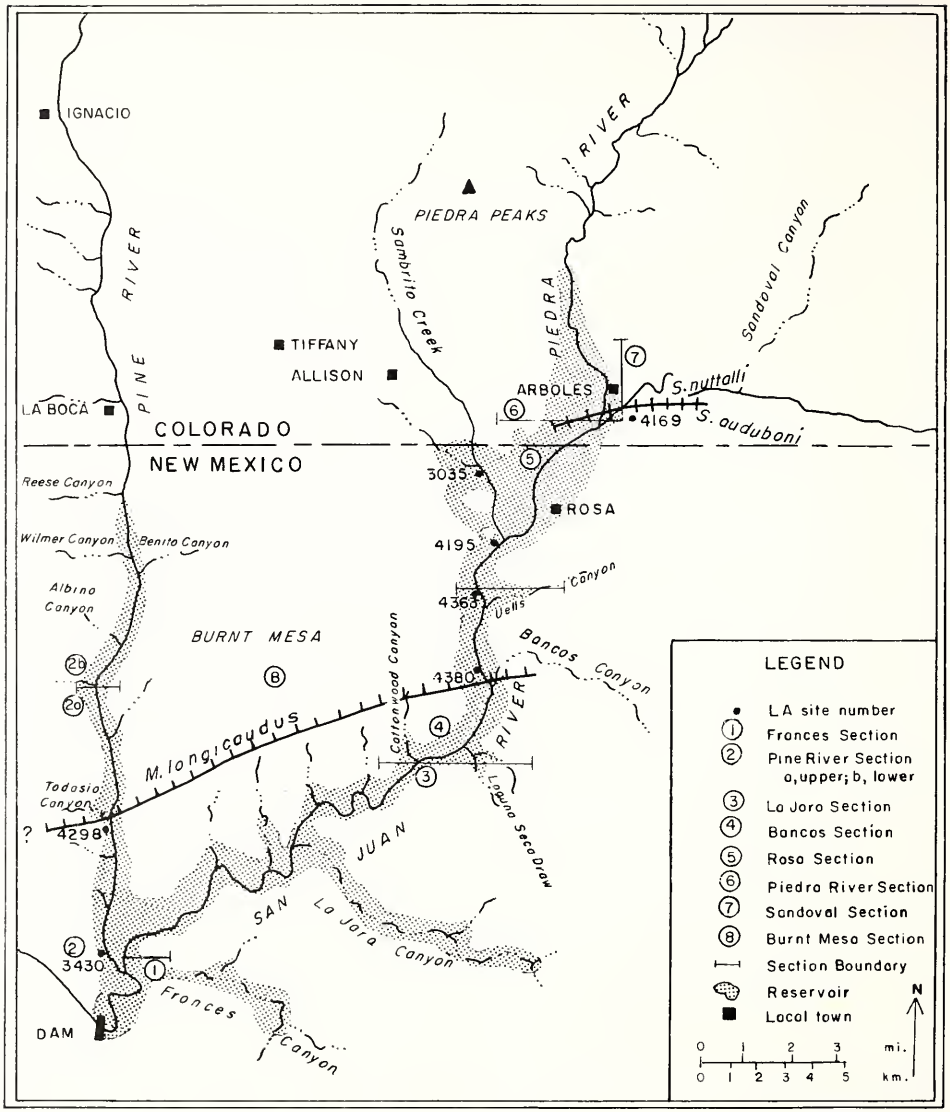


Fig. 20. Minimal southern limits of distribution of M. longicaudus and S. nuttalli and northern limit of distribution of S. auduboni during Sambrito Phase.

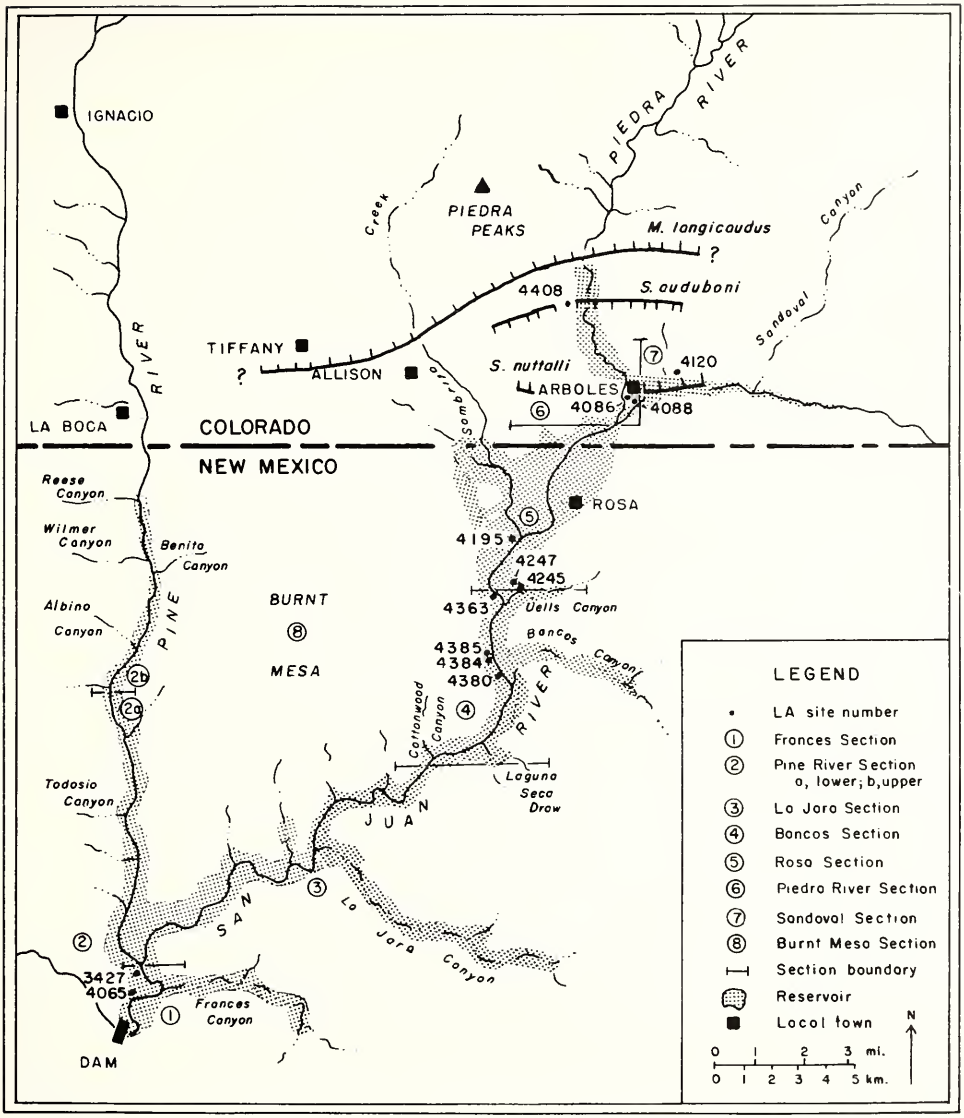


Fig. 21. Minimal southern limits of distribution of M. longicaudus and S. nuttalli and northern limit of distribution of S. auduboni during Rosa Phase.

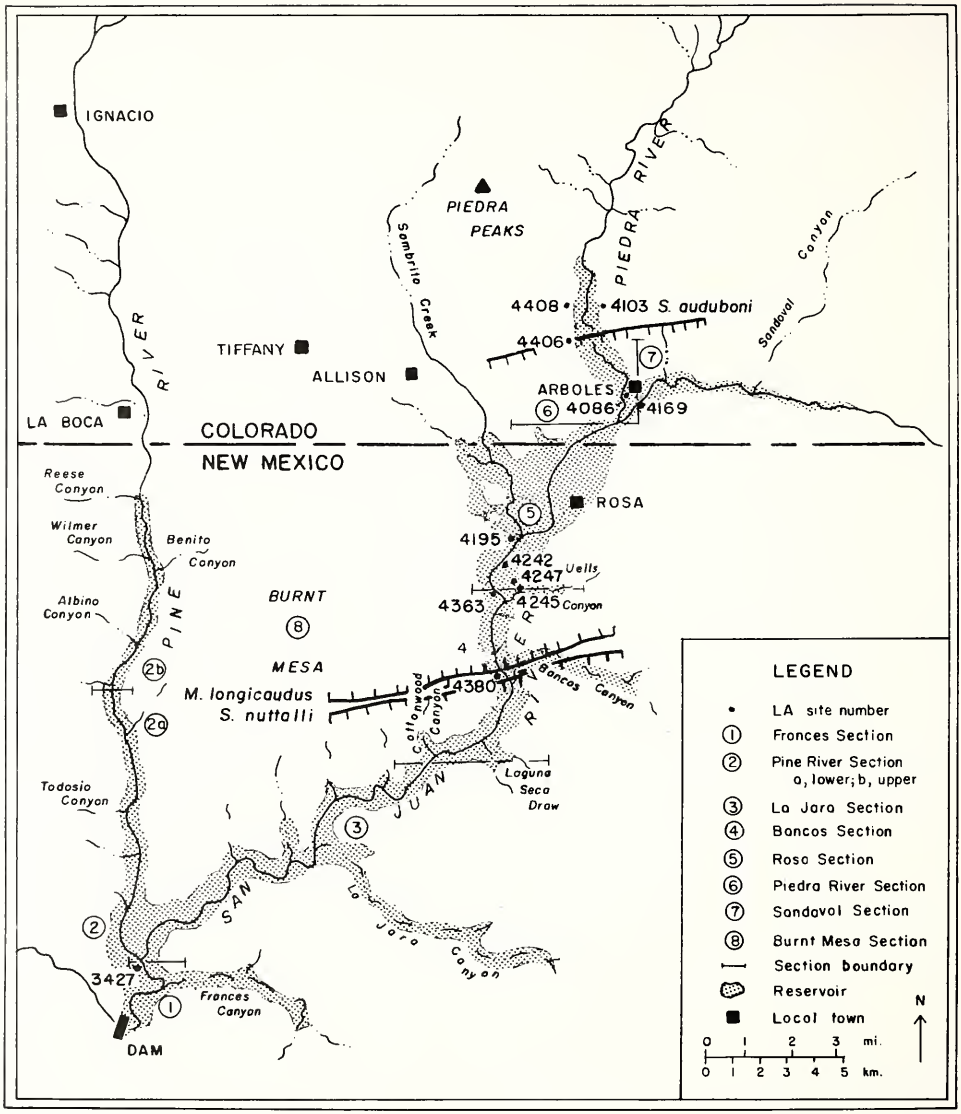


Fig. 22. Minimal southern limits of distribution of M. longicaudus and S. nuttalli and northern limit of distribution of S. auduboni during Piedra Phase.

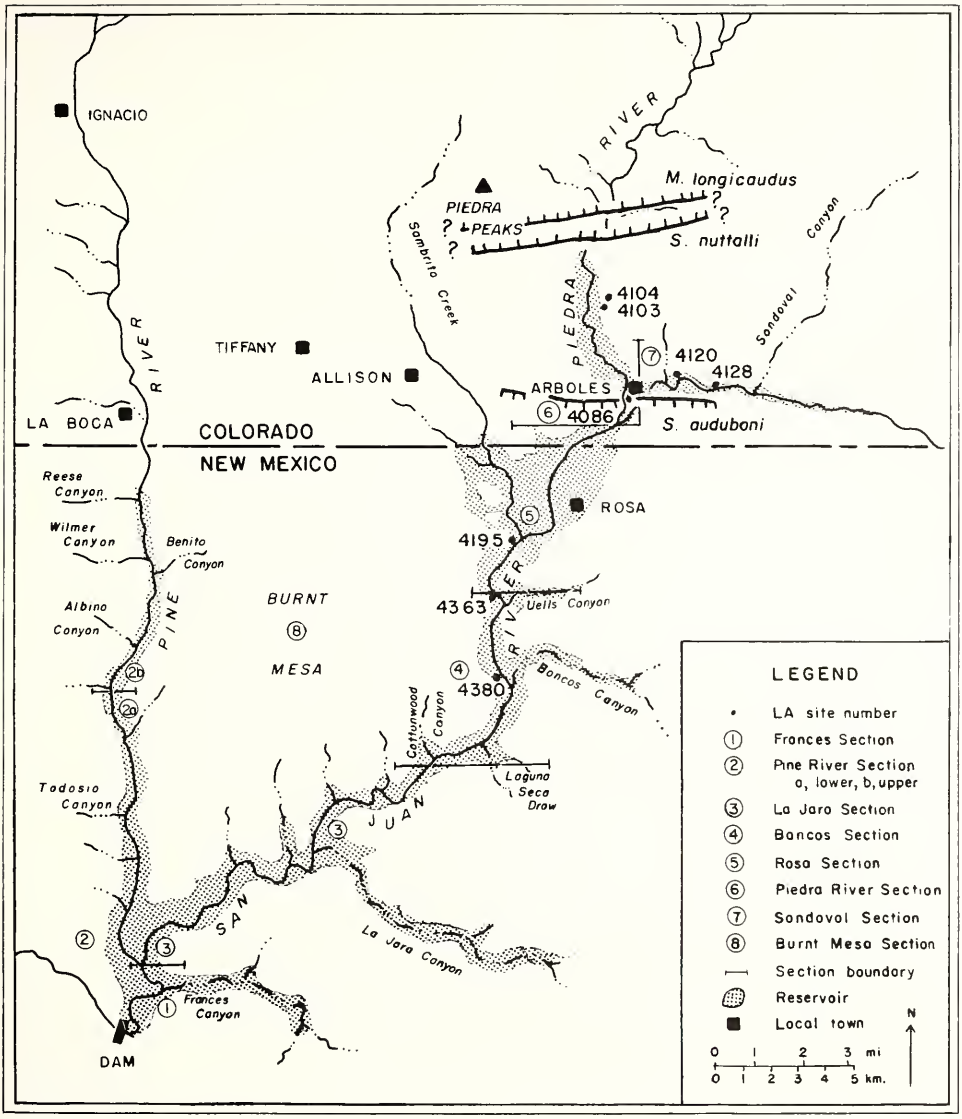


Fig. 23. Minimal southern limits of distribution of M. longicaudus and S. nuttalli and northern limits of distribution of S. auduboni during Arboles Phase.

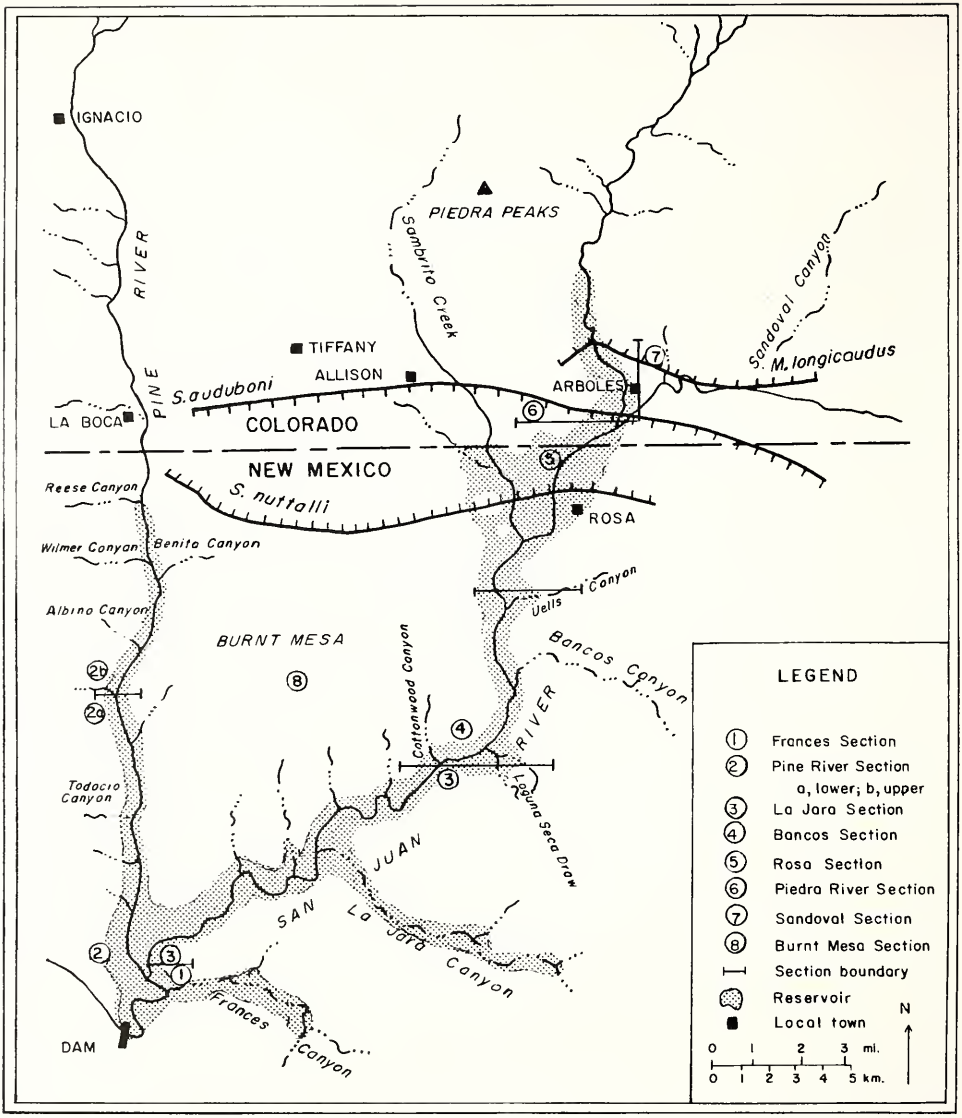


Fig. 24. Approximate southern limits of distribution of M. longicaudus and S. nuttalli and northern limit of distribution of S. auduboni at present.

continued expansion of big sagebrush during this period.

In Piedra Phase samples, M. longicaudus and O. leucogaster reappear; Perognathus is present, as it was in the Rosa-Piedra mixed sample. The presence of these animals might indicate a period of increased plant cover; but, more probably, these animals were present in small numbers in favored, restricted areas throughout Rosa time, and their presence in Piedra samples is owing, primarily, to the relatively large sample recovered from Piedra Phase excavations.

After Piedra Phase, Onychomys, M. longicaudus, and Perognathus are absent; Lepus remains common; Dipodomys, Lepus, and S. nuttalli levels indicate continuation of arid conditions, but not to the point of eradication of the former.

The Navajo Period sample appears more biased in favor of larger animals and rock dwellers than are most other samples. The ratio of S. nuttalli to S. auduboni suggests an increase in vegetal cover, at least during part of the Navajo Period, over that present in the Rosa-to-Arboles Phase span of time.

The presence of Microtus pennsylvanicus as far north as the Rosa Section indicates the presence of sedge beds or other marshy growth as late as about A.D. 975 - 1000, assuming correct dating. This poses the problem of the ecological and geographic relationships of M. pennsylvanicus and M. montanus. The respective habitats are somewhat similar and it has been assumed that the former is absent today from the suitable habitats at the northern end of the Reservoir area owing to its inability to compete successfully with the latter. It would appear that the presence of both would be possible in the same area. In such a case, it is suspected that M. pennsylvanicus would be limited strictly to the sedge portions and that M. montanus would be excluded from such habitat.

Unfortunately, there is no way to compare directly the frequencies within faunas recovered from archaeological material with those present today. The levels of the biases discussed in the Introduction cannot be estimated with any degree of accuracy. By assuming approximately equal bias, the archaeological bone samples may be compared with one another; they cannot be compared with the modern fauna except as the presence or absence of given members of the fauna.

The absence of D. ordi in modern times is probably the result of the combination of habitat somewhat marginal at best and depletion of much low plant cover owing to droughts of the past few hundred years (Schulman, 1956), to adverse grazing practices, or to a combination of these factors.

Microtus longicaudus barely enters the northern part of the study area today. It is considered probable that the present vegetal cover, even if not overgrazed, etc., would be insufficient for this animal over most of the Reservoir area. Its past presence probably indicates somewhat more mesic conditions than are present today.

One animal, present in fair numbers in the archaeological material, is not distributed as would be expected from what is known of its ecology, if the climatic events were as hypothesized above. Marmota flaviventris is presumably dependent upon green fodder throughout the warmer portion of the year (Howell, 1915, p. 13). Thus, recurring dry periods, such as occur now during spring and early summer in the study area, should exclude this animal from an area unless some other source of green fodder is available. Its presence today in the Reservoir area appears to be attributable to irrigation activity, although it is possible that the normal vegetation of Sambrito Creek would support this animal.

Instead of becoming less common during the period of postulated increasing aridity, the marmot's frequency in the samples increases throughout the Pueblo

Period, that is, from complete absence in the Los Pinos Phase to 6.5 per cent in the Arboles Phase. It is absent from the Navajo samples. No entirely satisfactory explanation has been proposed for this temporal distribution.

Several features warrant further discussion. Dittert, et al,. (1961) point out that the process of aggradation in the San Juan River evidently changed to one of degradation during the Pueblo Period. Judging on the basis of relationships of archaeological sites to materials laid down by the river, they conclude that degradation had begun at least by A.D. 900. They hypothesize that "After A.D. 800 or 900, a drier climate may have prevailed, characterized by a decrease in winter rainfall and a reduction in the mountain forest cover which controls upland slope run-off. More intense and/or more frequent summer storms caused rapid slope run-off, abnormal floods, and channeling of the floodplains."

It appears from the faunal evidence that a considerable change occurred near the end of Sambrito Phase or during Rosa Phase. The most likely period for rapid change is during early Rosa times (ca. A.D. 700 - 800). Sites identified with that time span appear scarce in the Reservoir area and the faunal remains are few. Thus, the main Rosa sample is from ca. A.D. 800 - 900; and by that time the major change had occurred. This does not prove that entrenchment of the floodplain was a synchronic event. The actual rise in frequency of S. auduboni in Rosa times, compared with Sambrito Phase, suggests that destruction of floodplain cover was not the sole reason for the change in ratios between S. auduboni and S. nuttali, and that this ratio change cannot be used as evidence of degradation. There is available some evidence that, either the river bed had not yet begun active degradation by ca. 900, or the normal stream flow was so sluggish as to allow growth of aquatic vegetation. Presence of muskrats at LA 3427, ca. 900, and at LA 4247, A.D. 800 -900, implies such a situation, but scarcely proves it.

The climatic conditions necessary for the presence of the low plant cover of pre-Rosa time may be hypothesized in broad outline. In reference to shrub-grasslands, Chapline and Cooperrider (1941, p. 473) have stated, "There must be rain sometime during the growing season for grasses, or their survival and growth must not be prevented through drying out of the upper soil layers during critical periods. A common condition is cold winter weather with precipitation enough to sink rather deeply into the ground, a critical annual dry period, and rain sometime during late spring or summer. The more rain in summer, the more prominent are the grasses." Summer precipitation, then, may have been considerably greater than in later times and/or have begun earlier in the season. A greater amount of rain in summer would not imply greater winter precipitation. The total annual precipitation must have been sufficient to support only pinyon-juniper woodland; a large increase in winter precipitation would probably have caused the replacement of woodland growth with ponderosa pine forest.

There is some faunal evidence from elsewhere in the Southwest at approximately the same latitude as the study area that there may have been increased precipitation in the course of the growing season during this period of time. Lange (1956) has brought together records of marmot remains in presently arid north-central and northeastern Arizona. One example which he cites is that of Woodchuck Cave, where the marmot remains could be dated by tree-rings at A.D. 200 ± 100. Bones from a cave in northcentral Arizona were associated with cultural material considered to date from about A.D. 750. One record, if truly associated with the cultural material, dates from later than the Reservoir area Pueblo record. This record

is from Kiet Siel, abandoned about A.D. 1300. The Reservoir area records, exhibiting their apparent conflict with other faunal evidence, may indicate a lack of knowledge of true limiting factors governing distribution of marmots. If this is the case, the Arizona records cannot be used as evidence of greater effective precipitation.

APPENDIX A

CULTURAL CONSIDERATIONS IN THE STUDY OF PREHISTORIC ANIMALS

by FRANK W. EDDY

Initial biological studies within the Navajo Reservoir District were concerned with modern animals and their habitats (Harris, 1963). This research provides a base to which prehistoric animals can be compared and on which their vegetation surroundings can be reconstructed, a work which is properly the subject of an ecologist; but, at least in the prehistoric field, it must be closely coordinated with the research of an archaeologist. It is the intention here to make this coordination by providing a cultural background, and to show what criteria have been employed in dating both cultural and biological events.

RESERVOIR CULTURAL SEQUENCE

Four cultural groups have utilized the geographic area now delimited as the Navajo Reservoir District. These groups are varied in their contents; distributions with in the Reservoir District; intensity of land use (site density); ages; and lengths of occupation. In order of appearance; these cultures are: 1) Archaic, 2) Pueblo, 3) Navajo, and 4) Historic. Each of these is also found widespread outside of the study District, sometimes in a more intensive expression, and the latter three groups are also represented by contemporary descendants; but the cultures will be considered only as periods of occupation within the Reservoir geographical area (Dittert, et al.,1961).

Subdivision of two of these periods, namely, the Pueblo and Navajo, is effected through a more restricted cultural unit referred to as the "phase", a unit defined by a distinctive cultural content and a restricted temporal-spatial limit (Willey and Phillips, 1958, pp. 22-24). These smaller units are convenient subdivisions for refined studies in cultural content, continuity of development, and change through time and space. In this report, they are also used as the basic reference units for studying shifts in the prehistoric Reservoir District environments. Their cultural descriptions are given below, in consideration of the understanding they give of the cultural context from which the biological data were obtained and of correlation of man with his changing environment.

Archaic Period
(3,000 to 500 B.C.)

Study of this occupation is based entirely on surveyed data, as no archaic sites have been excavated within the Reservoir District. A summary of this information appears in Dittert, et al.,(1961, p.213), where it is referred to as the Lithic Period.

It was concluded that this period is a Desert Culture way-of-life (Jennings, 1957, p. 6). Locally, this pattern is expressed as a culture of small game hunters and wild plant foragers, who consistently maintained a selective preference for sand dune camp sites, when these situations were available. Occupation was oriented towards mesa-top terrain away from, but often overlooking, the major rivers. Sites of the Archaic Period indicate a sparse population within the area of the Navajo Reservoir District, as compared to the area downstream and south of Blanco and Farmington. The situation and distribution of sites in this latter area imply that, in Archaic times, environmental conditions were more favorable than today and provided sufficient water, game, and vegetation to support prehistoric man (Dittert, 1958, pp. 7-11). Material culture items are related to the continent-wide Archaic Stage. Southwestern variants of this culture are Desert Culture adaptations to life in a semi-arid climate. Dating is based entirely on cultural comparisons with Archaic sites of similar content outside the Reservoir District.

Pueblo Period
(A.D. 1-1050)

In contrast to the Archaic Period, which does not figure in this bone study, the Pueblo Period provides the bulk of the biological data under consideration. In the original synthesis derived from site survey, two disjunctive periods were recognized: a Basket Maker and a Pueblo Period. More recently, excavation studies have shown that occupation was continuous, and for this reason both of the former periods have been combined into one Pueblo Period. This widespread unit is locally sub-divided into five phases, termed the Los Pinos, Sambrito, Rosa, Piedra, and Arboles.

LOS PINOS PHASE (A.D. 1-400)

An initial synthesis of this phase was given in the survey report of Dittert, et al., (1961, pp. 213-220). Subsequent excavations reported by Eddy (1961) defined the cultural unit in greater detail. Twenty-four known settlements are composed of from one to eleven cribbed log houses, ranged in a loose, open fashion among thin sheet deposits of refuse. Deep exterior storage and cooking pits are common. Sites are frequently situated on the front edge of Pleistocene (?) age benches within the Pine River Canyon, where they overlook the floodplain below. Site survey in the vicinity of Bayfield, Colorado, shows that Los Pinos sites are more heavily distributed just north of the Reservoir District along the Pine River (Green, personal communications).

The associated tool complex is composed of heavy percussion implements, particularly cobble choppers. Grinding tools show affinities with both the earlier Archaic Period and later Pueblo developments. Although present, fired ceramics do not make up a large part of the material goods. There are some indications that perishable forms of containers for liquids, such as tightly woven baskets, were in use. This material culture is bare but adequate for people who were just beginning to enjoy the fruits of sedentary village living supported by corn horticulture. The change in way-of-life compared to the earlier Archaic Period is impressive. The Los Pinos Phase is also the earliest known prototype for the lengthy later developments of the Pueblo Culture. Comparison with excavated sites in the Animas Valley north of Durango, Colorado, indicates that this phase is part of the Basket Maker II Period of the Pecos classification, which is known from the Four Corners area of the Southwest (Morris and Burgh, 1954).

Dating is based on three lines of evidence: 1) cultural comparisons with dendro-dated Basket Maker II sites, 2) the rare occurrence of ceramics, and 3) a series of six radio carbon dates extending from A.D. 117 $\pm$ 131 to A.D. 541 $\pm$ 80 .

SAMBRITO PHASE (A.D. 400 - 700)

This unit is newly defined from excavation studies and was not recognized from the site survey (Dittert, Eddy, and Dickey, 1963). It closes a gap previously thought to exist between the Los Pinos Phase and later developments of the Pueblo Period. For this reason, it is chiefly instrumental in lumping all of the phase units between A.D. 1 and 1050.

It was first recognized through studies of architectural stratigraphy at Sambrito Village (LA 4195) (Dittert, Eddy, and Dickey, n.d.). Seven sites are known, all but one from the San Juan Canyon (Fig. 20). Most of these were discovered by accident through excavation of later overlying structures. Since surface indications are not distinctive or evident, no relative statement on site distribution or density is possible.

The few excavated sites contain from one to twelve small, shallow pit houses, associated with deep exterior storage and cooking pits. At one site (LA 4169) a heavy concentration of burned ovens suggests specialized cooking activities. No surface houses are known. Surface refuse is rare-to-absent, another reason why the Sambrito Phase sites were not located on survey.

The tool complex includes some carryovers from the Los Pinos Phase, as well as new introductions. One of the outstanding material traits is the relatively common use of fired brown ware ceramics (Sambrito Brown). Most architectural features can be identified by the presence of several to a dozen pieces of Sambrito Brown and, in late structures (A.D. 600 - 700), some trade introduction of Chapin Gray, Twin Trees Plain, and painted ceramic types.

Cultural affiliations expressed in both architecture and ceramics suggest ties, and possibly a source, from the northern border zone of the Mogollon Culture. Similarities with the Lupton Phase (Wasley, 1960) of the Gallup area are suggestive of direction, but Lupton is not necessarily the parent of the Sambrito Phase. Within the Reservoir District, the Sambrito Phase appears to represent a small increment of population introducing some distinctive cultural elements and probably mixing with a few local people to provide the barest continuum of culture for the area.

Dating is based on house stratigraphy, stratigraphic position in an alluvial terrace bank, transitional sites which indicate continuity with earlier and later phases, and trade ceramics from the Mesa Verde District to the west. At the present stage of our knowledge, the Sambrito Phase seems to fall between the more securely anchored Los Pinos and Rosa Phases. It is temporally, but not culturally, equivalent to the Basket Maker III Period of the Pecos classification.

ROSA PHASE (A.D. 700 - 900)

This unit, as well as the succeeding two, formed part of the original three phases composing the Pueblo Period defined from the site survey (Dittert, et al., 1961, pp. 220-236). It was named and defined in some detail prior to the Reservoir studies. The definition was based on three excavations along Gobernador Canyon south of the Reservoir District, and unreported information obtained from excavations by H.P.Mera in the same area (Hall, 1944).

Sites of this phase, as well as of the succeeding two units, are composed of an associated set of pit houses and surface units for storage or living. Scattered refuse is often found nearby. Sites are typed, for purposes of settlement study, into three classes: Single Unit, Multiple Unit, and Village. The former have one pit house and are the most common type of residence, running over eighty per cent of the total number of components recorded. Multiple Unit sites contain from two to five pit houses, while Villages have six or more sub-surface residences.

In the Rosa Phase, pit houses have been developed into large, deep structures with distinctive floor details, such as a bench, fire basin, four-post roof-support pattern, ventilator, partitional walls, and storage bins, made of coursed coils which are attached to the wall or end of the bench. Also, in the Gobernador District, sites are surrounded by palisades composed of close-set, upright posts. Many of these architectural details persist into later times, but change is found in form and style.

Although Rosa Phase sites are found distributed throughout the Reservoir District, particularly along the San Juan River, the heaviest concentration is in the sections of the lower portion of the Reservoir District (Dittert, et al.,1961, Fig. 66).

Ceramics are well developed, hard-fired gray wares, which parallel developments in other Districts of the San Juan Basin; painted designs appear for the first time. Brown pottery persists as a minor utility ware, and some ceremonial objects, particularly pipes, retain this technology. Pottery becomes so common that it forms one of the major and diagnostic portions of the study of Pueblo Period sites. Other portable material items show advancement in workmanship and proliferation in number and types.

Dating of this cultural unit is based principally on the dendrochronological work of Hall (1944, Appendix F). His study in the Gobernador District showed a date cluster in the late 700's and early 800's. He employed a span of A.D. 700 - 900 to bracket these findings. This age range is projected into the Reservoir District, a conclusion based on the cultural similarity of remains. However, in the upper portion of the Reservoir District, the succeeding Piedra Phase is thought to begin fifty years before the close of the Rosa Phase in the south and, hence, an overlap is obtained. These datings are thought to be not inconsistent with the cultural findings, and they express the fact that cultural change was proceeding more rapidly in the north, probably owing to greater outside stimulation from the Mesa Verde District. In broad terms of the Pecos Classification, this unit would be classified, both culturally and temporally, as early Pueblo I Period.

PIEDRA PHASE (A.D. 850 - 950)

The Piedra Phase was defined on the basis of excavations by Roberts (1930) on Stolsteimer Mesa along the Piedra River north of the Reservoir District. Although these sites are employed as the type or comparative basis for this definition, the actual phase concept and specific term were not employed until some years later. Excavations in Mancos County, Colorado, have indicated some idea of the areal extent of this unit (Reed, 1958). Within the Reservoir District, the distribution of sites shifted to the middle portion of the San Juan River Valley (Dittert, et al.,1961, Fig. 67).

Significant attributes which have been added to the cultural inventory include: an increase in size of sites, particularly villages; use of the intercommunity Shabik'eshchee type kiva (Schroeder, 1963); refinements in ceramics toward greater sophistication in manufacture and design; and changes in tool forms (Dittert, et al., 1961, p. 221). Most of these findings are based on survey collections and unreported excavations, but a set of three sites just north of Uells Canyon has been reported by Greminger (1961).

Dating is securely anchored by analysis of tree-rings from Piedra components. These dates have been obtained by the Tree-Ring Laboratory of the University of Arizona and cluster with convincing regularity in the very late 800's. In terms of the Pecos Period classification, these sites are late Pueblo I.

ARBOLES PHASE (A.D. 950 - 1050)

This phase term designates the terminal occupation of the Pueblo Period. New traits which make their first appear-

ance are: the use of masonry in surface houses, refinements in ceramic technology and painted designs, tool types, and trade of foreigh lithic materials. Sites are almost entirely confined to the upper Reservoir to the north, it is believed that only the early portion of the Arboles Phase has been encountered within the study area. Demographic shift to the north up the major water courses is apparent, and post-salvage research will be required to search out the extent and changes involved in the late portions of the phase (Dittert, et al., 1961, Fig. 68).

Dating is based on cultural comparisons with contemporary events in the surrounding districts, particularly the Mesa Verde District to the west. These remains would be classified as early Pueblo II by the period criteria of the Pecos Classification.

Subsequent history of Pueblo peoples has taken place elsewhere in the Southwest, and the events of such history have not been recorded within the Reservoir District, except as a side issue during the Navajo Period.

Navajo Period
(A.D. 1550 - 1775)

Navajo archaeology is in its infancy and many of the aspects of it remain to be investigated. It is our belief that the Navajos are latecomers to the Southwest, having arrived from the High Plains through one or more passes over the San Juan Mountains. The earliest appearance of the Navajo Indians in the Southwest is recorded in the Reservoir District and the area immediately to the south. Here, their encounter with the Pueblo Culture exerted a profound influence on them. The earliest known Navajo culture is termed the Dinetah Phase, and it is assumed that this phase strongly resembles that of the Athapaskan group from which the Apache Indians also derive. During and immediately after the Pueblo Revolt (1680 - 1696), the Navajos came into close contact with Pueblo Indians, and in consequence adopted many Pueblo traits. This influence produced a situation which is termed the Gobernador Phase. Subsequent changes and developments of Navajo culture to the present day are not recorded within the Reservoir District, as the Navajos slowly migrated southwest to their present homeland reservation. For an over-all account of Navajo migrations and acculturations see Hester (1962).

DINETAH PHASE (A.D. 1550 - 1770)

The pre-Pueblo contact culture is meagerly represented in the archaeological record, and only six survey sites have been assigned to the Dinetah Phase, a very limited sample to study. Subsequent excavations have turned up detailed, below-the-ground data from five sites with a Dinetah component (Hester and Shiner, 1962;Dittert and Shiner, in preparation). Because of the limited nature of these data, reconstruction of this culture development is based largely on a subtraction of known Pueblo traits which leaves a residue termed Dinetah (Dittert, et al., 1961, pp. 245-246). The Dinetah Phase traits include: forked-stick hogans, Dinetah Utility pottery, agriculture (?), digging stick (?), and a short list of stone artifacts. Traits which represent initial contact with the Pueblo culture are: Jemez Black-on-White pottery, a specialized type of knife, and domestic animals. More detailed examination by means of excavation has enlarged this list to include wooden beads and the gathered-heel sandal (Hester and Shiner, 1963).

Although it was postulated that the Dinetah Phase extended beyond the limits of the Reservoir District, few other sites are now known. Dating is tentative, and is based on trade of dated pottery types (Jemez Black-on-White), historical records, and questionable dendro-dates (Dittert, et al., 1961, pp. 244-245).

GOBERNADOR PHASE (A.D. 1700 - 1775)

Navajo culture, showing strong influence from the nearby Refugee Pueblo

peoples, is well represented within the Reservoir, both in terms of number of sites (170) and quantity of material goods. Unlike the earlier manifestation, the Gobernador Phase had been previously studied and defined in the work of Keur (1944) and Farmer (1942) in the Gobernador District to the south. Material traits within the Reservoir include: forked-stick hogans; pueblitos (small masonry structures perched on, or built against, large talus boulders); ramadas; exterior cooking pits; metate rests; slab mealing bins; cremation (?) rock art (Schaafsma, 1963); pottery mentioned previously, plus polychrome and Pueblo trade pieces; and a more elaborate list of stone and of other types of artifacts than was found in the Dinetah Phase. Presence of corn and beans indicates that the Navajo were versed in horticulture and, indeed, employed it as an economic base.

Distribution of the above sites is widespread throughout the Reservoir District; but particularly so in the lower portion near the junction of the two rivers (Dittert, et al.,1961, Fig. 74). Beyond the study area, Gobernador Phase sites are common within the Gobernador District, the nuclear center of this phase. Casual inspection of site situations has shown occupation to extend as far north as Pagosa Junction, Colorado, on the San Juan River. Although separation based on archaeological remains often is not possible, I believe that the large pueblito sites in the Gobernador District probably were occupied by Refugee Pueblo Indians, while most of the hogan sites of the Reservoir District were homes of purely Navajo families. However, considerable mixture of architectural types (hogans and pueblitos) is present from the lower portion of the Reservoir District southward; these, probably, were residences of intermarried, mixed groups in which cultural interchange was taking place.

Dating of these manifestations is effected in the same manner as for the Dinetah Phase, except that in this case the data are voluminous and trustworthy.

Historic Period
(A.D. 1870 - present)

The local expression of historic European occupation is termed the Lucero Phase, and is principally composed of Spanish-Americans who homesteaded in the Reservoir District at about 1870. Most of these people practiced a subsistence farm economy until recently, when this pattern of life tended to break down under the influence of the national cash economy. However, until there occurred purchase of land by the Bureau of Reclamation for creation of the Reservoir, some families continued to live on small farms in isolated sections of the Reservoir District canyons. For further details, see Dittert, et al. (1961, pp. 250-259).

DATING CULTURAL AND BIOLOGICAL EVENTS

The prehistoric bones which form the body of data examined in this paper have been obtained by the excavation of thirty-seven archaeological sites. The identifications derived from these bones are correlated with the archaeological data shown on Figure 2, where the dating of each provenience location is given. We are concerned in this section with the research procedures which produced these dates, which are employed both in archaeological and biological studies.

Associations

A basic archaeological premise, upon which the dating methods described below are founded, is that materials consistently occurring together were deposited in

their present location at about the same time. Thus, bones, plant remains, cultural tools, ceramics, and other items found in a prehistoric house are all assumed to be of the same age; and a date derived from any of the material can be applied to the whole lot. In actual practice, some interpretation of the meaning of this association is necessary in applying the dating. In this study, associated material from the floor and collapsed roof of any structure is thought to be associated with the house. However, a tree-ring date obtained from an examination of construction timbers probably dates the original construction or some phase of repair, while the ceramics from this same provenience are more apt to date the actual occupation up to fifty or more years after construction. Again, the fill of a structure represents wash into the architectural depression after abandonment and house collapse; it is definitely post-occupation, although a later date may not be detectable through archaeological methods.

A further example of the principle of association is found in burials where grave goods are placed with an interment as a religious offering. The individual and the items buried with him are assumed to be contemporaneous. However, dating of the associated set may be distorted by the inclusion of heirloom pieces which were retained in the family for several generations and have since gone out of manufacturing style. Other illustrations could be given of types of associated goods and special problems in interpreting their meaning. The detailing of such illustrations will have to await the reporting of the individual sites. However, the basic premise of association may be applied here in dating the archaeology and the included biological data.

Ceramic Dating

The essential framework of culture and chronology employed in this study is based on the study of ceramic typology, because of a need for a reference point for studies of material culture change, cross-correlation between geographic areas through consideration of trade pieces, and dating. Use of ceramics in these studies is analogous to the use of "guide fossils" by the stratigraphic geologist; the implicit premises are borrowed substantially intact. Underlying principles are: 1) styles of ceramic manufacture change slowly but persistently; for any given area they parallel those found throughout wider regions, owing to communication of ideas; 2) types of ceramics, which are based on attributes such as kind of clay (paste), temper (grit), surface color, firing technique, and painted or surface manipulated designs can be established and independently recognized by co-researchers; and 3) the quantitative occurrence of these types in a stratigraphic or architectural situation will change, following a bell-shaped curve; that is, at any given point in time, types will continuously be losing or gaining popularity. An assessment of the percentages present will facilitate placement of the lot on a developmental scale, which must be constructed for each district of study. Within the Navajo Reservoir District, a sequence of painted ceramic types extends from Rosa Black-on-White through Piedra Black-on-White to Arboles Black-on-White. If examination of a given house has yielded a count or visual assessment of twice as many Piedra Black-on-White sherds as Arboles Black-on-White, it would be deduced that the structure was of late Piedra Phase, A.D. 900 - 950, and probably more toward 950 than 900. The original dating of the ceramics was based on the association of types with dendro-dated structures. During the early stages of research in the Navajo Reservoir District, ceramic type dating was derived from surrounding districts by means of cross-correlation with trade pottery. As excavations proceeded and dendro-dates became available for the Reservoir District itself, further refinement and checking of these correlations became possible. The description of many of these types employed here, both local and traded, has been presented in Dittert,

et al.(1961, pp. 135-154). The dating is shown graphically in Figure 37 of the report just mentioned. New types, principally derived from the plain, undecorated wares, are now being constructed, and some refinements in dating are being made as cultural studies continue.

Ceramic dating in this present study was made by a visual inspection of ceramic lots obtained from every architectural provenience or any other provenience which also produced prehistoric animal bones. Detailed counts were not made, but it is felt that the visual inspections provide a reasonably accurate assessment of the cultural phase, date of the provenience, and date of associated animal bone. Undoubtedly, some adjustments will be indicated when the final laboratory analysis is made for each unreported site, but I believe that no change will involve a block of time as great as the phase unit. The biological use of these cultural data is sound.

Dendrochronology

The Tree-Ring Laboratory of the University of Arizona is studying prehistoric wood obtained from the Navajo Project excavations. Dendro-dates presently available are carried to the right of the estimated age range shown on Figure 2. Dates from LA 4195 and LA 4408 are omitted because they have already been published (Dittert, et al., n.d. and Hester, 1962). Most of the dates apply to the original house construction, although some subsequent repairs and re-using of timbers from older, abandoned structures probably took place. In general, a cluster of dates means that original construction is indicated, while isolated dates are less reliable for temporal interpretations. For a discussion of interpretive problems in tree-ring analysis, see Bannister (1962, pp. 508-514). As an aid in assessing the value of dates, a suffix is appended by the dendrochronologist indicating the condition of the outside growth ring. These symbols and their meanings are as follows:

v- Outside shows erosion, last ring variable around circumference. If no other symbol, unknown number of rings lost.
vv- Outside shows extreme erosion, last ring very variable around circumference. If no other symbol, unknown number of rings lost.
c- Last ring constant around circumference, probable cutting date.
r- Outermost ring continuous around the portion of specimen present, possible cutting date.
G- Beetle galleries present on surface, very near cutting date.
B- Bark present on surface, definite cutting date.

Those dates suffixed with symbols "c" to "B" are reliable in direct application, whereas those followed by a "v" must be interpreted as being earlier by an unknown number of years than the cutting date. Where a disagreement occurs between the dating of ceramics and the tree-rings, one must keep in mind that the house construction should date somewhat earlier than the ceramic material on the house floor. However, general correlation of the two dating approaches, applied independently (that is, when ceramic dating was performed before the tree-ring dates were received), has shown good correspondence. The cluster of all tree-ring dates slightly before A.D. 900 provides a sound horizon marker for ceramic and site dating during the mid-Piedra Phase (A.D. 850-950).

Other Guides to Dating

Less commonly used dating methods include: radio-carbon, stratigraphy, style change in non-ceramic tools, and architecture. The Los Pinos Phase largely lacks ceramics, and dating is almost entirely based on C-14. The temporal range of six dates is A.D. 117 $\pm$ 131 to 541 $\pm$ 80. However, four of the six dates fall in the 100's and 200's. It is estimated from this information that the phase dates from A.D. 1-400 (Eddy, 1961, pp. 102-103, 106).

Because of the meager cultural remains and sparse populations during certain time periods, the accumulation of occupation debris in the Reservoir District is not common. For this reason, stratigraphic studies are not as important in the Reservoir District as elsewhere in the Southwest. However, some situations do lend themselves to this approach. Examples of superposition are found in the case of architecture, especially at large pit house village sites. An important relative order has been demonstrated between Piedra Phase houses and underlying structures of the Sambrito Phase. Other examples of stratigraphy are found in refuse-filled pit houses, where the trash has been thrown into the abandoned pit depressions, and also in alluvial situations where Sambrito and Rosa components are buried in the Recent floodplain deposits of the San Juan River.

Style change in tools and items other than ceramics is a helpful temporal marker. For instance, the true hafted axe first appears in the Reservoir District by the beginning of the Rosa Phase; earlier, the hand chopper is employed in heavy-duty cutting. Another example of a time guide is found in architectural styles where cobble-ring houses are characteristic of the Los Pinos Phase; small, shallow, cup-shaped pit houses are found in the Sambrito Phase; and, thereafter, deep structures laid out in a formal manner. Masonry construction is present to a very limited extent in the Reservoir District; it first appears in the early Arboles Phase.

Conclusions

Through use of the dating techniques reviewed here, I believe that chronology is reasonably secure and sound for the Reservoir District cultural sequence and, by association, for the prehistoric animal bones under study. Using this phase and temporal framework, the animal complexes described in the body of this text can be dated in units of time as fine as fifty years, within a span of A.D. 700 - 1050. Earlier, the blocks of time available for the Los Pinos and Sambrito Phases are 300-400 years long, although some instances of more precise placement at the end of the Sambrito Phase are occurring. Again, the Gobernador Phase (A.D. 1700 - 1775) is secure, based on ceramic dating; but the preceding Dinetah Phase (A.D. 1550 - 1700) lacks a firm dating foundation.

Using the above findings, the animal lists presented in Figure 2 were arranged chronologically and the phase distribution maps (Figs. 19-23) were compiled.

APPENDIX B

LIST OF PREVIOUS NAVAJO PROJECT STUDIES

Study Number	Publication
I	Dittert, A.E.Jr. 1958 Preliminary Archaeological Investigations in the Navajo Project Area of Northwestern New Mexico. Museum of New Mexico Papers in Anthropology, No. 1. The Museum of New Mexico and the School of American Research.
II	Dittert, A.E., Jr., J.J.Hester, and F.W.Eddy 1961 An Archaeological Survey of the Navajo Reservoir District of Northwestern New Mexico. Monograph of the School of American Research and the Museum of New Mexico, No. 23.
III	Greminger, H.C. (Assembler) 1961 Papers from a Training Program in Salvage Archaeology. Museum of New Mexico Papers in Anthropology, No. 3.
IV	Eddy, F.W. 1961 Excavations at Los Pinos Phase Sites in the Navajo Reservoir District. Museum of New Mexico Papers in Anthropology, No. 4.
V	Hester, J.J. 1962 Early Navajo Migrations and Acculturation in the Southwest. Museum of New Mexico Papers in Anthropology, No. 6.
VI	Schaafsma, P. 1963 Rock Art in the Navajo Reservoir District. Museum of New Mexico Papers in Anthropology, No. 7.
VII	Harris, A.H. 1963 Ecological Distribution of Some Vertebrates in the San Juan Basin, New Mexico. Museum of New Mexico Papers in Anthropology, No. 8.
VIII	Hester, J.J. and J.L. Shiner 1963 Studies at Navajo Period Sites in the Navajo Reservoir District. Museum of New Mexico Papers in Anthropology, No. 9.
IX	Dittert, A.E., Jr. and F.W. Eddy (Assemblers) 1963 Pueblo Period Sites in the Piedra River Section, Navajo Reservoir District. Museum of New Mexico Papers in Anthropology, No. 10.

BIBLIOGRAPHY

Bailey, V.
1915 Revision of the Pocket Gopher of the Genus Thomomys. North American Fauna, No. 39. U.S. Government Printing Office. Washington, D.C.

1931 Mammals of New Mexico. North American Fauna, No. 53. U.S. Government Printing Office. Washington, D.C.

Bannister, B.
1962 The Interpretation of Tree-Ring Dates. American Antiquity, Vol. 27, No. 4, pp. 508-514.

Chapline, W.R. and C.K. Cooperrider
1941 Climate and Grazing. In Climate and Man: Yearbook of Agriculture, 1941, pp. 459-476. U.S. Department of Agriculture. Washington, D.C.

Dittert, A.E., Jr.
1958 Preliminary Archaeological Investigations in the Navajo Project Area of Northwestern New Mexico. Museum of New Mexico Papers in Anthropology, No. 1. Santa Fe.

Dittert, A.E., Jr., J.J. Hester, and F.W. Eddy
1961 An Archaeological Survey of the Navajo Reservoir District of Northwestern New Mexico. Monograph of the School of American Research and the Museum of New Mexico, No. 23. Santa Fe.

Dittert, A.E., Jr., F.W. Eddy, and B. Dickey
1963 Evidence of Early Ceramic Phases in the Navajo Reservoir District. El Palacio, Vol. 70, Nos. 1-2, pp. 5-12. Santa Fe.

n.d. Excavations at Sambrito Village, Navajo Reservoir District. Museum of New Mexico Papers in Anthropology, (in preparation). Santa Fe.

Dittert, A.E., Jr., and F.W. Eddy (Assemblers)
1963 Pueblo Period Sites in the Piedra River Section, Navajo Reservoir District. Museum of New Mexico Papers in Anthropology, No. 10. Santa Fe.

Dittert, A.E., Jr. and J.L. Shiner
n.d. Studies at Navajo Period Sites in the Navajo Reservoir District, Part II. Museum of New Mexico Papers in Anthropology, (in preparation). Santa Fe.

Durrant, S.D. and N.K. Dean
1961 Mammals of Navajo Reservoir Basin in Colorado and New Mexico, 1960. In Ecological Studies of the Flora and Fauna of Navajo Reservoir Basin, Colorado and New Mexico, edited by D.M. Pendergast, University of Utah Anthropological Papers, No. 55. Salt Lake City.

Eddy, F.W.
1961 Excavations at Los Pinos Phase Sites in the Navajo Reservoir District. Museum of New Mexico Papers in Anthropology, No. 4. Santa Fe.

1963 Excavations at the Candelaria Site, LA 4406. In Pueblo Period Sites in the Piedra River Section, Navajo Reservoir District, assembled by A.E. Dittert, Jr. and F.W. Eddy, Museum of New Mexico Papers in Anthropology, No. 10. Santa Fe.

Evans, G.E. and V.P. Foley
1961 The Excavation of LA 4245. In Papers from a Training Program in Salvage Archaeology, assembled by H.C. Greminger, Museum of New Mexico Papers in Anthropology, No. 3, pp. 26-41. Santa Fe.

Farmer, M.
1942 Navajo Archaeology of the Upper Blanco and Largo Canyons, Northern New Mexico. American Antiquity, Vol. 8, No. 1, pp. 65-79.

Finley, R.B., Jr.
1958 The Wood Rats of Colorado: Distribution and Ecology. University of Kansas Publications Museum of Natural History, Vol. 10, No. 6, pp. 213-552. Lawrence.

Greminger, H. (Assembler)
1961 Papers from a Training Program in Salvage Archaeology. Museum of New Mexico Papers in Anthropology, No. 3. Santa Fe.

Greminger, H.C. and B. Cox
1961 The Excavation of LA 4242. In Papers from a Training Program in Salvage Archaeology, assembled by H.C. Greminger, Museum of New Mexico Papers in Anthropology, No. 3, pp. 12-25. Santa Fe.

Hall, E.T., Jr.
1944 Early Stockaded Settlements in the Governador, New Mexico. Columbia Studies in Archaeology and Ethnology, Vol. 2, Pt. 1. New York.

Harris, A. H.
1963 Ecological Distribution of Some Vertebrates in the San Juan Basin, New Mexico. Museum of New Mexico Papers in Anthropology, No. 8. Santa Fe.

Hester, J.J.
1962 Early Navajo Migrations and Acculturations. Museum of New Mexico Papers in Anthropology, No. 6. Santa Fe.

1963 Excavations at the Serrano Site, LA 4408. In Pueblo Period Sites in the Piedra River Section, Navajo Reservoir District, assembled by A.E.Dittert, Jr. and F.W.Eddy, Museum of New Mexico Papers in Anthropology, No. 10. Santa Fe.

Hester, J.J. and J.L.Shiner
1963 Studies at Navajo Period Sites in the Navajo Reservoir District. Museum of New Mexico Papers in Anthropology, No. 9. Santa Fe.

Howell, A.H.
1915 Revision of the American Marmots. North American Fauna, No. 37. U.S.Government Printing Office. Washington, D.C.

Jennings, J.D.
1957 Danger Cave. Memoirs of the Society for American Archaeology, No. 14.

Keur, D.L.
1944 A Chapter in Navajo-Pueblo Relationships. American Antiquity, Vol. 10, No. 1.pp.75-86.

Lange, A.L.
1956 Woodchuck Remains in Northern Arizona Caves. Journal of Mammalogy, Vol.37, No.2, pp.289-291.

McVicker, D. and W. Lenington
1961 The Excavation of LA 4247. In Papers from a Training Program in Salvage Archaeology, assembled by H.C.Greminger, Museum of New Mexico Papers in Anthropology, No. 3, pp. 42-67. Santa Fe.

Morris, E.H. and R.F.Burgh
1954 Basket Maker II Sites Near Durango, Colorado. Carnegie Institution of Washington, Publication 604. Washington, D.C.

Pendergast, D.M. (Editor)
1961 Ecological Studies of the Flora and Fauna of Navajo Reservoir Basin, Colorado and New Mexico. University of Utah Anthropological Papers, No. 55. Salt Lake City.

Reed, E.K.
1958 Excavations in Mancos Canyon, Colorado. University of Utah Anthropological Papers, No. 35. Salt Lake City.

Roberts, F.H.H., Jr.
1930 Early Pueblo Ruins in the Piedra District, Southwestern Colorado. Bureau of American Ethnology, Bulletin 96. Washington, D.C.

Schaafsma, P.
1963 Rock Art in the Navajo Reservoir District. Museum of New Mexico Papers in Anthropology, No. 7. Santa Fe.

Schroeder, A.H.
1963 Diffusion North Out of South-Central Arizona. El Palacio, Vol. 70, No. 1-2, pp.13-24. Santa Fe.

Schulman, E.
1956 Dendroclimatic Changes in Semiarid America. University of Arizona Press. Tucson.

Sciscenti, J.V., A.E.Dittert, Jr., and B. Dickey
1963 Excavations at the Martinez Site, LA 4104. In Pueblo Period Sites in the Piedra River Section, Navajo Reservoir District, assembled by A.E.Dittert and F.W.Eddy, Museum of New Mexico Papers in Anthropology, No. 10. Santa Fe.

Wasley, W.W.
1960 Salvage Archaeology on Highway 66 in Eastern Arizona. American Antiquity, Vol.26, No. 1, pp. 30-42.

Willey, G.R. and P. Phillips
1958 Method and Theory in American Archaeology. University of Chicago Press. Chicago.

Date Due

Due	Returned	Due	Returned

Withdrawn from UF. Surveyed to Internet Archive

Vertebrate remains and past en main
572.082S231p no.11 C.2
3 1262 03324 2016

cover design by Joseph Haydock

printing by Vergara Printing Company